POWER

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Purposeful Anecdotes

Some Straws That Show

"Have I kept you waiting?" asked the chief as he entered the room where the applicant for a job was sitting. He pulled out his watch as he spoke, and the caller, as the chief evidently expected him to do, looked at his also —so did the chief.

Some men cannot talk without a pencil in their fingers. The chief soon began to grope in his vest pocket, and ended by asking the caller for one. He did not have any either.

The chief took an unsharpened pencil from the drawer of his desk, but had to borrow a knife from his visitor with which to sharpen it.

In a few minutes the applicant was being shown out.

"He won't do," said the chief. "Watch is wrong—no precision. I can tell a good deal about a man by the kind of a pencil he carries and the condi tion it is in, as to point, etc., but a man who carries no pencil cannot do much thinking or observing that is worth putting down.

"And then his knife—dull, blackened blades with the points broken off. He has 'been going to get it sharpened,' but he hasn't.

"He is full of great things that he could do or is going to do, but cannot show much that he has done.

"Good intentions make good paving, but are poor building materials for success.

"And then his personal appearance—and he was dolled up for this call, too.

"It is easy to imagine what his desk and plant would look like after a week or two.

"No, he would be as bad a misfit as the sweet girl graduate we had there before."

Fort Wayne Station Rebuilt

By Thomas Wilson

SYNOPSIS—The double-deck station has a number of inherent advantages, such as short steam piping, compact arrangement and low initial investment. Initially 6000 kw. in six turbo-generators were placed on the second floor, and although extra steelwork was provided to carry the load, the absence of special side bracing permitted vibration, which gave no end of trouble and resulted in placing the generating plant on the ground level. The station now has a capacity of 12,500 kw. in 60-cycle machines, 3000 kw. in 25-cycle generators and equipment to interchange the current. The load runs close to 100,000 kw.-hr. per day, of which 45 per cent. is 60-cycle service and 55 per cent. railway load.

Back in 1907 the Fort Wayne & Wabash Valley Traction Co., now known as the Fort Wayne & Northern Indiana Traction Co., installed an interesting double-deck station for which extravagant claims were made at the time. The plant was to supply current to both lighting and traction systems, the generating capacity being divided equally between 60- and 25-cycle machines and totaling 6,000 kw. Owing to the absence of periodical vibration arising from unbalanced parts, turbines were selected as the prime movers. The machines were placed on the second floor and their weight was distributed between the building walls and two rows of steel columns, which rested on special footings. The ground area covered by the building reduced to 1.10 sq.ft. per kilowatt of generating capacity, although on the single-deck basis this increased to 2.9 sq.ft. The cost of the station complete, exclusive of substation apparatus but including main-line transformers, was only $66.25 per kilowatt of generating capacity. Excluding the building and erection cost, the money invested for equipment did not exceed $50 per kilowatt.

No doubt the plant would have come up to expectations had not vibration interfered seriously with its operation. Under difficulties imposed by this vibration, service was maintained for seven years, but when additional capacity became imperative, by reason of the increasing load, it was decided to remodel the station and place the generating plant on the ground level. The logical place for the turbine room was on the east side of the old station, but there was a space of only 35 ft. between the station wall and the street and the stack had been placed on this side near the center. The layout shown in Fig. 4 was finally adopted. Eventually, a stack will be placed at either end of the boiler room and the old one removed, so that space will be available for additional generating capacity.

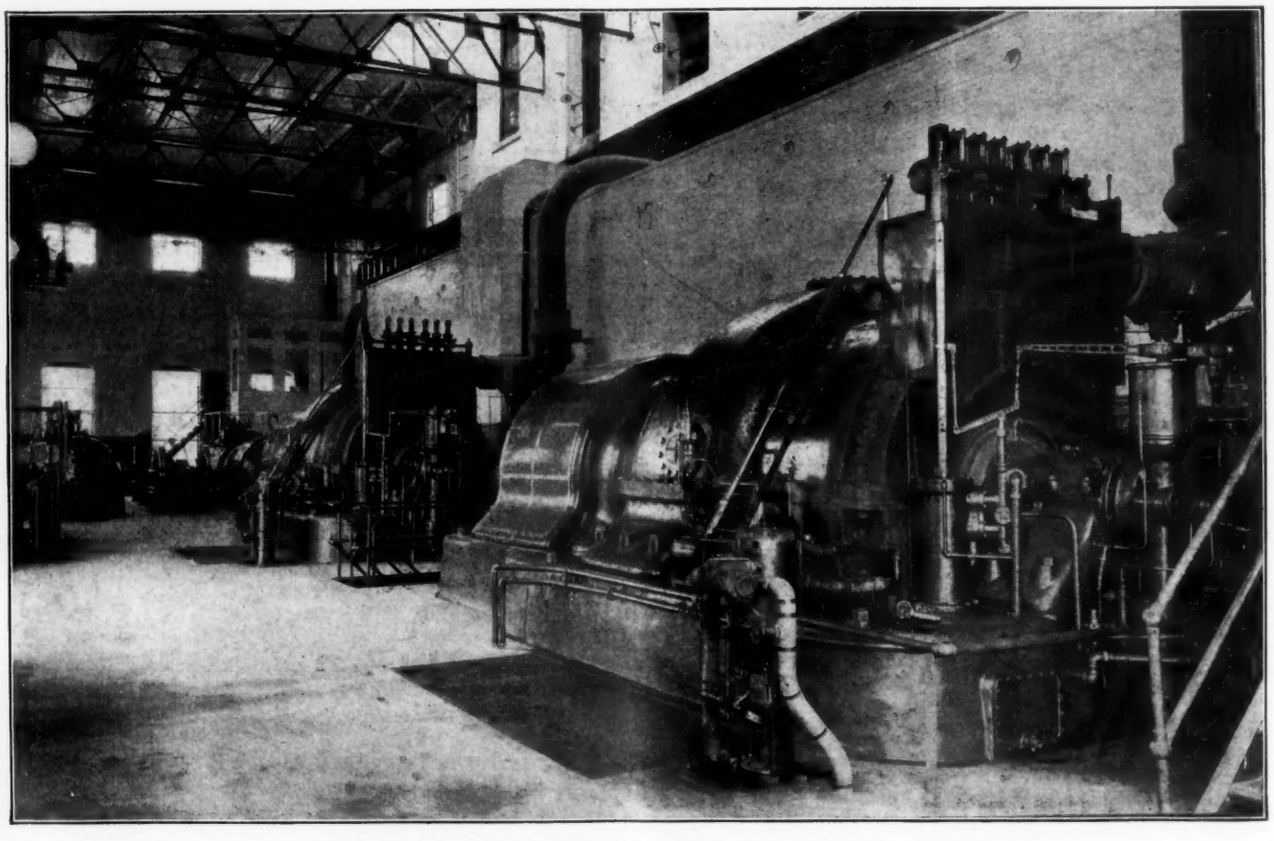


FIG. 1. TURBINE ROOM OF SPY RUN POWER PLANT

In this new turbine room, two of the old 1,500-kw. 25-cycle machines were installed and two new 60-cycle turbo-generators, each rated at 6,250 kw. at 80 per cent. power factor. Immediately below each turbine a surface con-

denser was placed and a cooling-water circulating system common to the four units was installed. The boiler installation, consisting of ten 400-hp. units, was increased by two 450-hp. boilers. The operating pressure was raised from 165 to 185 lb. and the old furnaces were remodeled.

The plant now supplies current to 140 miles of interurban lines. Current for this service is generated at 420 volts and is stepped up to 35,700 volts for transmission. The two 1,500-kw. machines are required the greater part of the time for this service, and when additional 25-cycle current is needed it is obtained from the 60-cycle end

The equipment now consists of ten 400-hp. horizontal water-tube boilers and two 450-hp. units of the same type, making a total of 4,900 boiler horsepower, Fig. 3. The ground plan of the boiler room measures 47 ft. by 177 ft. 2 in. The total area is thus 8,340 sq.ft., and per boiler horsepower this reduces to 1.7 sq.ft. In comparison with the same unit, 3.16 kw. of generating capacity is installed.

The boilers are of the three-pass type, vertically baffled. The gases pass out at the rear into a rectangular flue running the length of the boiler room. The stack is placed near the center, so that on each wing of the flue there are

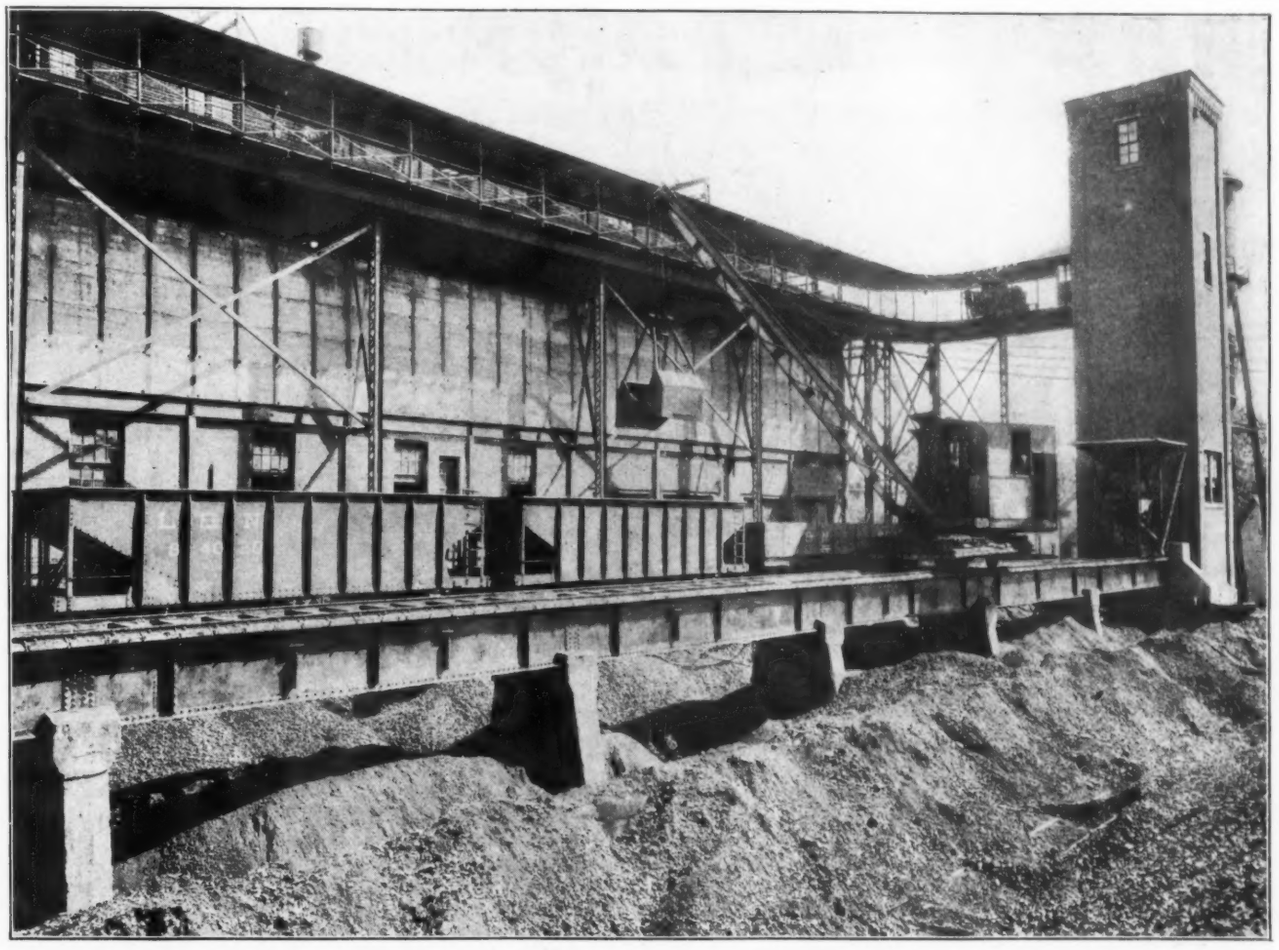


FIG. 2. EXTERIOR OF STATION, SHOWING COAL-HANDLING APPARATUS

through a 1,000-kw. frequency changer installed in the old turbine room.

Traction service for the city of Fort Wayne, 620-volt direct-current, is also supplied through two 1,000-kw. motor-generator sets, and a 375-kw. rotary converter carries a special elevator load.

Three-phase 60-cycle current for light and power is generated at 4,100 volts and is consumed mostly in the City of Fort Wayne. The load will average close to 100,000 kw.-hr. per day of 24 hr. Roughly, 55 per cent. of this is traction load and 45 per cent. is 60-cycle commercial service. The remodeling was fully completed in November of 1914, and in subsequent operation the cost of producing current has been considerably reduced, by reason of a better vacuum from the surface condensers, turbines more efficient than the old units, a thorough cleaning of the boilers, the reconstruction of the furnaces and the installation of improved stokers of the same type.

six boilers. The radial-brick stack is 180 ft. high and 12 ft. in diameter. Readings at the bottom show a draft of approximately 1 in. At the stack side of the damper this reduces to 0.6 in. and over the fire the draft will average about 0.3 in., depending on the thickness of the fuel bed, the character of the coal and the position of the boiler. The smoke flue measures 8x10 ft. and the opening into the stack is 8x16 ft., giving an area of 128 sq.ft., which may be compared to 113 sq.ft., the sectional area of the stack. The projected grate area under each 400-hp. boiler is 83 sq.ft. and for the 450-hp. boiler, 95 sq.ft. The ratio to the heating surface is therefore 1 to 48.2 and 47.3, respectively. Per 100 sq.ft. of heating surface there is 2.08 sq.ft. of connected grate, 0.26 sq.ft. of smoke flue and 0.23 sq.ft. of stack.

Originally the stokers were set flush-front. As they are of the inclined-grate type, the combustion space was too small to give the best results. Consequently they

were moved back 3 ft. and a special arch was provided, 10 ft. wide, 5½ ft. long with a spring of 20 in. It is made up of 13-in. blocks, and in the 3-ft. extension in front of the tube header these blocks are spaced ¼ in. apart. Air passing through these openings from above keeps the blocks relatively cool and increases the life of the arch. The ignition effect at the front end of the furnace is reduced, the volatile driven off more slowly and hot air is supplied at the proper point to mix with the gases and improve combustion.

Coal- and Ash-Handling Apparatus

Eastern Ohio and West Virginia coal averaging about 13,500 B.t.u. per lb. is burned, and normally from 150 to 200 tons is required per day. An overhead bunker for gravity feed to the stokers has a capacity of 800 tons. This is sufficient to run the plant only four or five days, but a large storage pit on the premises, combined with a reliable coal-handling system, obviates any danger of shortage in the fuel supply. The pit, Fig. 2, is served by two tracks from which bottom-dump cars may empty directly into storage or be unloaded by means of a locomotive crane if it is desired to pass the coal through the crusher. The latter is mounted on wheels and may be pulled along the track or transferred to a space beside the pit reserved for storage. The capacity of the concrete pit is 3000 tons, and on the ground beside it there is room for an additional 5000 tons. With a 2500-lb. bucket the crane will easily handle 50 tons per hour.

At the bottom of the pit, delivery chutes equipped with undercut gates have been provided. Through these gates the coal passes into industrial cars, which are raised by means of an electric elevator to the level of the bunker. The cars are then pushed along an industrial track and their contents tilted over into the elevated bunker. The labor cost of handling the above amount of coal per day is $6.50. Per ton this would mean less than 4c.

From a concrete pit under the stoker, the ashes are pulled out into industrial cars. The latter are pushed to the end of the boiler room and by means of a 1-ton air hoist are elevated to an industrial track and their contents dumped directly into railway cars after the coal has been unloaded.

About 90 per cent. of the feed water is condensate from the surface condensers serving the main turbine units; the rest is water from the St. Joe River. It is good in quality, but contains enough impurities to prevent the pure condensate from pitting the boilers. From the tunnel supplying circulating water for the condensers, water for general house service is pumped to a 50,000-gal. tank elevated 80 ft. above the ground. From this source the makeup is drawn, a float in the two open heaters controlling the amount introduced. Connection to the city mains provides a second source on which to draw in case of emergency. The heaters are of 3000- and 5000-hp. capacities, respectively, and with the exhaust from the auxiliaries maintain the feed water at a temperature close to 200 deg. There are three boiler-feed pumps—two of the reciprocating type and one a centrifugal pump having a capacity of 300 gal. per min. The latter is generally used, but is relieved by the other two pumps when necessary. All feed lines are provided with water relief valves,

FIG. 3. BOILER ROOM OF SPY RUN POWER PLANT

the feed pumps with pressure governors, and each boiler is equipped with an automatic water regulator.

As previously stated, the new generating room, Fig. 1, contains four units—two of 1500-kw. capacity each, delivering 25-cycle current, and the other two, 60-cycle machines rated at 6250 kw. Of the latter units the prime movers are six-stage horizontal impulse turbines revolving at 1800 r.p.m. The generators are of the three-phase four-wire type delivering current at 4100 volts. On each machine the exciters are mounted at the end of the shaft, and in addition an independent 100-kw. turbine-driven exciter has been provided. This independent unit is generally used and particularly to excite the 25-cycle machines, as it was found advisable to boost the generating

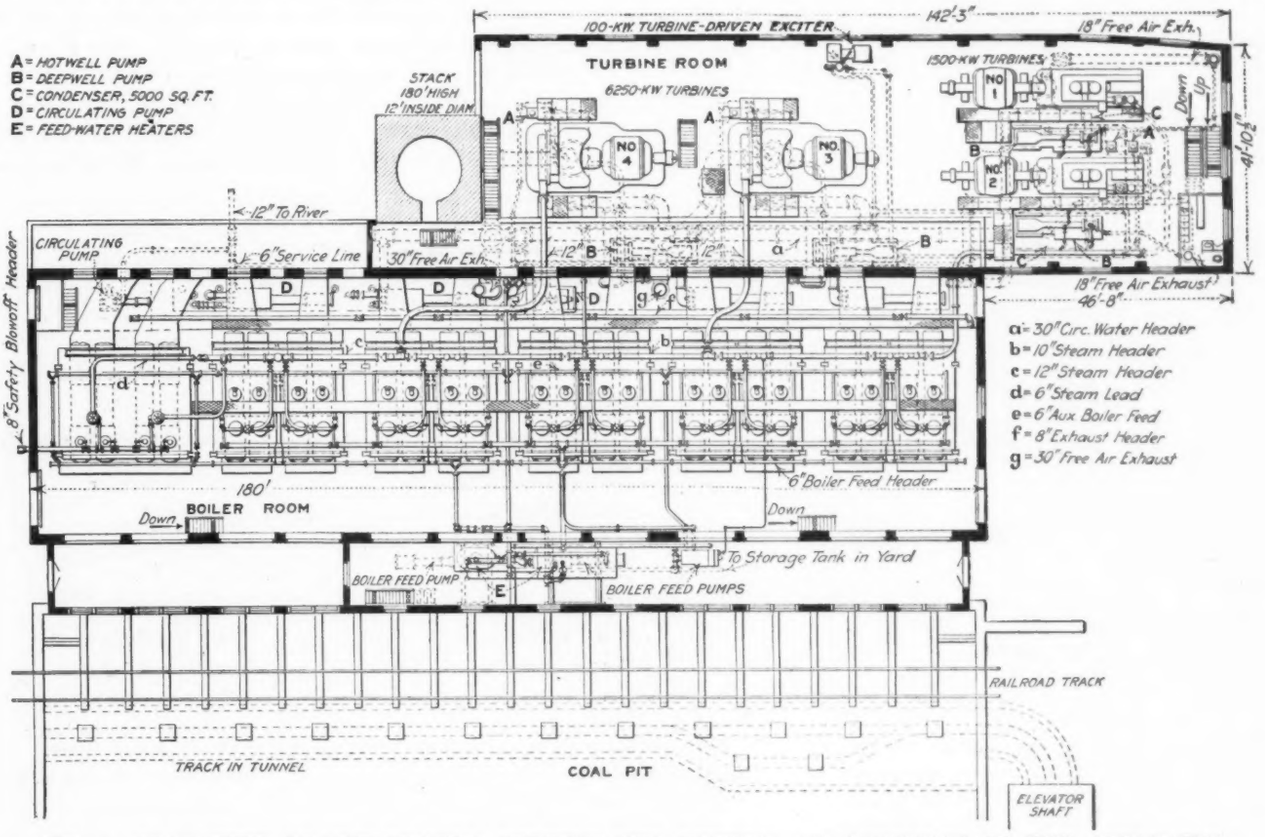


FIG. 4. PLAN VIEW OF THE STATION, SHOWING THE GENERAL ARRANGEMENT OF THE APPARATUS

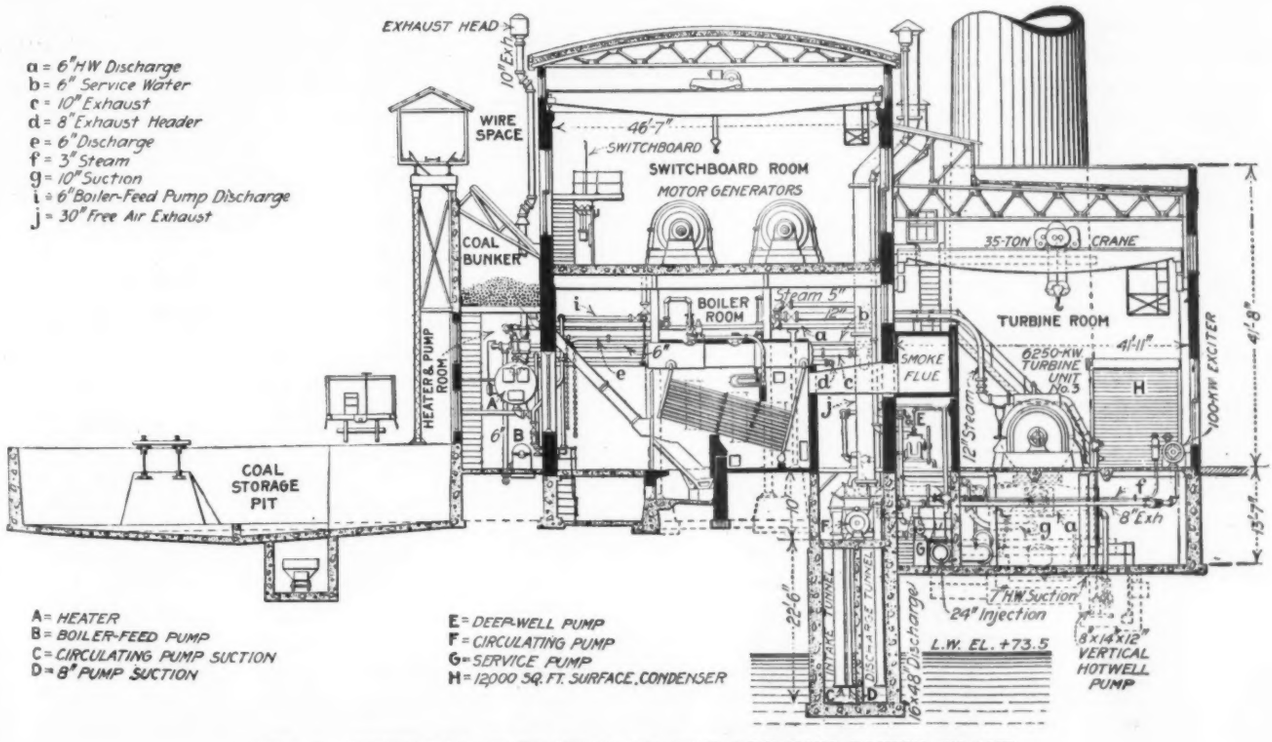


FIG. 5. SECTIONAL ELEVATION OF THE SPY RUN POWER PLANT

voltage from 375 to 420. To accomplish this the field excitation was increased and the independent exciter operated at 150 volts.

All of the main generators are air-cooled. The basement of the new addition is divided into two compartments. Into one the cold air is drawn from the exterior, forced through the generators and discharged into the hot-air compartment, which is sealed and contains the two large condensers and several auxiliary pumps. A number of vents allow the hot air to escape by natural circulation to the roof. This arrangement prevents it from getting back into the engine room and precludes some of the noise caused by the rotating elements.

of the line. Instantaneous communication is therefore possible between the switch and turbine rooms. As the former is located on the second floor of the old building and not in close touch with the turbine room, some such system was necessary.

Piping for the main generating units has been arranged as shown in Figs. 4 and 5. The supply pipes to the large turbines are 12 in. diameter and were figured for a steam velocity of about 5000 ft. per min. Per kilowatt of generating capacity the sectional area of the pipe reduces to 0.018 sq.in. The two 1500-kw. turbines are supplied from a 10-in. extension to the main header, and a 5-in. loop supplies all of the auxiliaries. That the piping may be readily distinguished, the following color scheme has been adopted: Live-steam piping, yellow; exhaust piping, red; hot-water lines, green; cold-water lines, black.

PRINCIPAL EQUIPMENT OF FORT WAYNE SPY RUN POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
10	Boilers	Horizontal water-tube	400-hp	Generate steam	185 lb. pressure, natural draft, superheat, 75 deg	Babcock & Wilcox Co.
2	Boilers	Horizontal water-tube	450-hp	Generate steam	185 lb. pressure, natural draft, superheat, 75 deg	Babcock & Wilcox Co.
12	Stokers	Inclined-grate		Serve boilers		Westinghouse Machine Co.
1	Stack	Radial-brick	12 ft. diam., 180 ft. high	Draft for boilers	Six boilers on each side	Heine Chimney Co.
1	Heater	Cast-iron, open	3000-hp	Heat feed water	Exhaust from auxiliaries	Platt Iron Works Co.
1	Heater	Steel-shell, open	5000-hp	Heat feed water	Exhaust from auxiliaries	Wm. Baragwanath & Son
2	Pumps	Simplex, double-plunger	24x12x24-in	Boiler feed	185 lb. steam	Boyts, Porter & Co.
1	Pump	Centrifugal	6-in., 300 gal. per min	Boiler feed	4-stage, turbine driven, 2700 r.p.m.	Alberger Pump & Condenser Co.
2	Pumps	Simplex, double-plunger	10x12x24-in	Service pumps	Water from tunnel to elevated tank	Boyts, Porter & Co.
1	Crane	Locomotive	50 tons per hr	Coal handling		Orton & Steinbrenner
	Industrial cars		1000-lb	Coal from storage to bunker	Pushed by hand	C. W. Hunt Co.
1	Elevator	Electric	5-ton	Elevate coal cars	Driven by 50-hp. motor	Otis Elevator Co.
1	Air hoist		1-ton	Elevate ash cars		C. W. Hunt Co.
	Industrial cars		1000-lb	Ashes from pits to railway cars		C. W. Hunt Co.
2	Turbines	Horizontal impulse	6250-kw	Main generating units	185 lb. steam, 75 deg. superheat, 1800 r.p.m.	General Electric Co.
2	Generators	Three-phase, 4-wire	6250-kw	Main generating units	4100 volts, 60-cycle, 1800 r.p.m.	General Electric Co.
2	Condensers	Three-pass surface	12,000 sq.ft	Serve 6250-kw. turbines	Steam-driven auxiliaries	Henry R. Worthington
2	Pumps	Reciprocating, Corliss gear	10x23x18-in	Dry vacuum		Laidlaw-Dunn-Gordon
2	Pumps	Vertical reciprocating	10x14x14-in	Hotwell		G. F. Blake Manufacturing Co.
2	Turbines	Single-flow reaction	1500-kw	Main railway units	185 lb. steam, 75 deg. superheat, 1500 r.p.m.	Westinghouse Machine Co.
2	Generators	Three-phase, 25-cycle	1500-kw	Main railway units	425 volts, 1500 r.p.m.	Westinghouse Elec. & Mfg. Co.
2	Condensers	Three-pass surface	5000 sq.ft	Serve 1500-kw. turbines	Steam-driven auxiliaries	Henry R. Worthington
2	Pumps	Reciprocating, Corliss gears	10x16x18-in	Dry vacuum		Laidlaw-Dunn-Gordon
2	Pumps	Vertical, reciprocating	6x10x12-in	Hotwell		Henry R. Worthington
4	Pumps	Simple, double-acting	24x36x48-in	Circulating water	Steam, 185 lb	Boyts, Porter & Co.
1	Pump	Centrifugal	12-in., 8000 gal. per min	Circulating water	Driven by 13x12-in. vertical engine	Alberger Pump & Condenser Co.
2	Generators	Direct-current	60-kw	Excite 6250 kw. generators	Mounted on generator shafts	General Electric Co.
2	Generators	Direct-current	37.5-kw	Excite 1500-kw. generators	Mounted on generator shafts	Westinghouse Machine Co.
1	Generator	Direct-current	100-kw	Exciter	Turbine-driven, 3600 r.p.m.	General Electric Co.
1	Oiling system		1000 gal. per 24 hr.	Turbine lubrication		S. F. Bowser & Co.
1	Pump	Duplex	4x6x4-in	Circulate oil		Henry R. Worthington
2	Motor-generators		1000-kw	City railway system	4100-620 d.-c., 375 r.p.m.	General Electric Co.
1	Rotary converter		375-kw	Elevators and special work	550 volts d.-c., 375 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Frequency changer		1000-kv.-a	60 to 25-cycle or vice versa		General Electric Co.
1	Storage battery		64-cell	Operate oil switch motors and Klaxon		Electric Storage Battery Co.
1	Crane	Traveling electric	25-ton	In switchboard room		Niles-Bement-Pond Co.
1	Crane	Traveling electric	35-ton	In turbine room		Northern Engineering Works

The turbines are provided with an oiling system common to the four units, equipped with a filter having a capacity of 1000 gal. per 24 hr. The oil may flow intermittently or continuously from the turbines to a receiver in the basement, and after passing through the filter it is returned by means of a duplex oil pump. The turbines are equipped with remote control, and communication between the switchboard operator and the machine attendant is made possible by a push-button visual signal system with an electric bell to draw attention. In the switchboard room the signal dial with its eight instruction cards is mounted on the bench board. In the turbine room the dial is mounted on a pedestal beside each machine. Depending upon which button is pushed, the corresponding instruction card is illuminated at both ends

The Condensers and Auxiliaries

The condensers are of the three-pass surface type employing 1-in. brass tubes. For the large units they have 12,000 sq.ft. of surface, which is approximately 2 sq.ft. per kilowatt of generating capacity, and for the smaller 25-cycle machines each condenser has 5000 sq.ft. of surface or 3⅓ sq.ft. per kilowatt. With one exception the pumps are of the reciprocating type. Rotative dry-vacuum pumps have been installed. The hotwell pumps are of the vertical type, the steam end being on the turbine-room floor and the pump in the basement beside the condenser.

For circulating the cooling water, the four reciprocating pumps used for the old jet condensers have been retained and a new centrifugal pump having a capacity of 8000 gal. per min. has been added. All of these pumps are connected to a circulating system common to the four condensers.

From the St. Joe River, 150 ft. distant, two concrete tunnels bring the circulating water to the plant and return it to the river. Under the plant the tunnels are arranged side by side, so that the pumps draw a fresh supply of water from one tunnel and discharge it into the other. Outside of the plant the return tunnel has been placed on top of the supply tunnel. An outlet on the downstream side returns the water to the river.

Because of the great difference in water level during the different seasons of the year, it was necessary to make special arrangements to guard against flooding the plant. The high-water line is nearly on a level with the basement ceiling, so that if the water had free access the basement would be filled, covering condensers and pumps. To prevent this, three gates, hand-operated by racks and pinions, were installed at the intake crib. One gate controls the inlet to the plant, the second affords communication between the supply and discharge tunnels and the third controls the discharge to the river. Ordinarily, the discharge and inlet gates are open and the gate controlling the opening between the two tunnels, closed. In time of flood, however, the discharge gate is closed, the inlet gate is opened slightly and the intermediate gate is left full open. The discharge water is thus returned to the supply tunnel and reused, with just enough cool water from the river to keep down the temperature. Any surplus which may accumulate is pumped back to the river through an independent discharge pipe above the high-water level.

Electrical Control Apparatus

All control and switching apparatus has been placed in the old turbine room. The 25-cycle equipment has not been changed, but the 60-cycle apparatus has been rearranged and added to. New busses and switching equipment have been installed in duplicate and arranged so that any generator or feeder may be transferred from one to the other without interrupting the service. All oil switches are arranged for remote control. Those recently installed are operated by motor and the old equipment on the 25-cycle service by solenoids. When one of these switches opens, a Klaxon electric horn draws the attention of the switchboard attendant. A 64-cell storage battery in conjunction with a small direct-current machine supplies the current for the horn and oil-switch motors. Should both sources fail, this service may be thrown onto the exciter bus.

Aluminum-cell arresters have supplanted the old multiple-gap units. The oil switches have been placed in concrete compartments, and all equipment has been brought up to date.

The remodeling of the station was conducted by Sargent & Lundy, of Chicago. S. W. Greenland is general manager of the traction company; E. S. Myers is electrical engineer, and W. J. Maxwell, chief engineer of the station.

The Extensive Use of Aluminum may be judged from the fact that its output for 1914 was nearly 80,000,000 lb., while back in 1884 the production was only 150 lb. and ten years later 550,000 lb.

Primary Mercurial Standards of Resistance

Although electric light and power are today in almost universal use, the average consumer pays little attention to the manner in which the amount of his bill is determined. He knows that his consumption of current is reckoned from his meter, but he does not know how the meter was originally adjusted or how it is checked from time to time to determine if its indications are correct. Only in rare instances does he know very much about the electrical units in terms of which the measurements are expressed, and he knows still less concerning the fundamental electrical units to which these measurements are referred.

These fundamental units—the ohm (the unit of resistance), the ampere (the unit of current) and the volt (the unit of electromotive force)—were defined by the International Congress on Electrical Units and Standards (London. 1908) and have since been internationally adopted.

The Bureau of Standards has just issued "Scientific Paper No. 256," dealing with the construction of four standard ohms. This unit was defined by the London congress as the electrical resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of a length of 106.3 cm. The work done at the Bureau of Standards consisted of the construction of material standards representing the unit realized in the form of mercury columns in glass tubes, and the work involved measurements of the highest accuracy of the length, the departure from uniformity of the cross-section and the mercury content of each tube, as well as their comparison with the working standard. All measurements had to be made at the melting temperature of ice prepared from specially purified water, which was used in order to avoid any temperature uncertainty due to possible impurities in the ice. Electrical comparisons of the four standards showed the average deviation of their individual values from their mean value to be less than 1/100,000 of an ohm.

England, Germany, France, Russia, Japan and the United States now have mercury standards of resistance which all agree to a high accuracy.

Similarly accurate work has been done at the bureau with regard to the ampere and the standard volt, so that the public can be assured that the electrical standards maintained at their national standardizing laboratory are of an accuracy far exceeding anv commercial requirements.

Piston-Ring Allowances—The making of automobile piston rings is more of a job than at first appears, if we pay the proper attention to the work they are to do. The allowance for expansion depends on the heat of the cylinder and piston, this in turn being somewhat dependent on the amount of metal in the piston itself. The practice of one piston-ring maker who makes individual cast rings, may serve as a guide to other sizes. For a 3¾-in. size the ring is cast 4 in. outside diameter, rough-ground and cut at 45 deg., so as to close to the size required for grinding to 3¾ in. less the clearance. This clearance is 0.009 in. for the upper ring, 0.007 in. for the second ring and 0.003 in. for the lower. The piston is also ground in about this proportion, and the grooves are turned with smooth sides. This is a point which seems to be overlooked by some automobile-motor builders, the grooves being left somewhat rough. The high spots wear down and leave the ring loose in the groove and allows "ring slap" in the cylinder.

Will Quizz, Jr.

SYNOPSIS—The difference in the compression curve on indicator diagrams from different engines starts Will Quizz wondering and asking questions. Being a negative force, he reasons that it is unnecessary and wasteful. Chief Teller demonstrates the necessity of compression and that it is not of itself wasteful.

"Why is it, Chief, that short-stroke, high-speed engine diagrams show a whole lot of compression, and long-stroke, Corliss-type especially, have only a little nipped off the corner? Each may have the same piston travel per minute at that."

"The question is somewhat involved, Will, but for practical purposes we can arrive at the right conclusion, I think, without going into all the refinements of the calculation.

"Suppose we compare the action of three engines of extreme dimensions, all to have a common piston speed of 720 ft. per min., and disregarding the angularity of the connecting-rod for the present, No. 1 to have a stroke of 360 ft. and make only one revolution per minute, No. 2 to have a 6-ft. stroke and make 60 r.p.m., and No. 3 to have a 1-ft. stroke and make 360 r.p.m. Suppose again, for convenience, that the reciprocating parts are of the same total weight, that is, the piston, piston rod, crosshead and connecting-rod.

"Take a look at the illustration. Let the horizontal line represent one stroke of the piston of No. 1, or 360 ft., the upper half of the large circle the crank's path for 180 deg., or half a revolution. Dividing this semicircle into 30 equal spaces, each space will represent 6 deg., which will also be the distance the crankpin will have to travel in one second (6 deg. into 360 deg. goes 60 times = 60 sec.) for the minute required to complete one revolution. Therefore, a vertical line dropped from each of these points represents the position the piston has reached at a given time, and the distance it has to travel each second. You will notice that the lines are quite close together at the two sides and further apart at midstroke. The two half-circles inside may be taken as two strokes each one-half the length of the first, for an engine making twice the number of revolutions, and the still smaller ones for an engine smaller in proportion. It would appear that the little fellow makes a series of moves and pauses or jumps on the way across, but it gets there at the same time that the big fellow does."

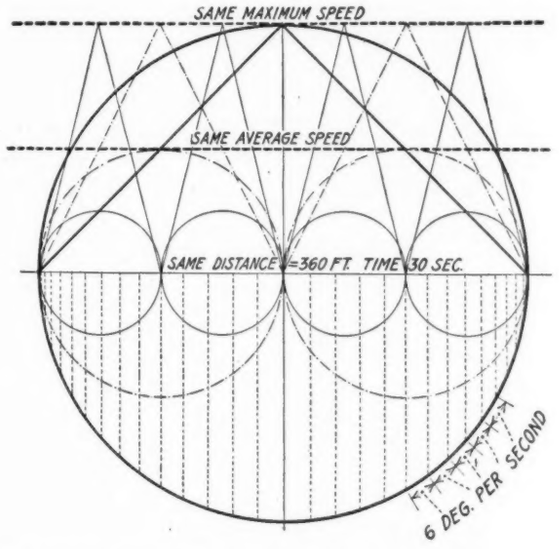
"Then it must go faster between stops, Chief? Like a local train making numerous stops, it must go faster between stations to get to the end of the run in the same length of time that an express train would require, would it not?"

"But, Will, the speed is fixed; that is, the crankpins travel at the same speed in feet per minute in each case. The distance around the large circle is the same as the sum of the circumferences of any number of smaller ones drawn tangent to each other in a line across inside of the large one. So with the pistons making the same distance per minute and the pins also the same maximum speed at midstroke and the same average speed as shown, where does the little one, or the local train as you made the comparison, get the time to stop several times?"

"I have it! The little one gets under way in less time than the large one, and also checks down in less time. But, Chief, it must take relatively more power to get up to speed and come to a stop in so much shorter time."

"That's first rate, Will; of course it does. The air brakes must be pretty good to make such a short stop. Just so with the piston, there must be more power expended to stop its motion in a shorter time. That is just why it takes more cushion at each stroke for a high rotative speed for the same piston speed than for a slow-speed long-stroke of equal piston speed.

"Take two engines, one with 72-in. stroke at 60 r.p.m., the other with 12-in. stroke at 360 r.p.m.; the piston speed



RELATIVE TIME OF PISTON ACCELERATION. SAME PISTON AND CRANKPIN SPEED BUT DIFFERENT ROTATIVE SPEEDS

in both cases is 720 ft. per minute. The first makes 120 strokes in 60 sec., or $60 \div 120 = \frac{1}{2}$ of a second per stroke; the second makes 720 strokes in 60 sec., or $60 \div 720 = \frac{1}{12}$ sec. per stroke. The first makes a stroke of 6 ft. in $\frac{1}{2}$ sec., or $6 \div \frac{1}{2} = 12$ ft. per sec. average crosshead velocity; the second makes a stroke of 1 ft. in $\frac{1}{12}$ sec., or $1 \div \frac{1}{12} = 12$ ft. per sec. average crosshead velocity.

"With the same ratio of connecting-rod to stroke, the velocity at any point in the stroke will be the same. The piston of the short-stroke engine will be moving at the same speed at $\frac{1}{10}$ or $\frac{1}{2}$ stroke as is the piston of the larger engine at the same points in its stroke.

"Suppose the exhaust valve to close when the return stroke is $\frac{4}{5}$ completed. Then the moving parts have got to be brought to rest in each case while the piston makes $\frac{1}{5}$ of its stroke. In the case of the larger engine this is

$$\frac{1}{5} \text{ of } 6 \text{ ft.} = \frac{6}{5}, \text{ or } 1.2 \text{ ft.}$$

In the case of the smaller engine it is

$$\frac{1}{5} \text{ of } 1 \text{ ft.} = \frac{1}{5}, \text{ or } 0.2 \text{ ft.}$$

In this time each pound of mean effective compression will absorb 1.2 ft.-lb. for each square inch of the piston

of the larger engine. But it will absorb only 0.2 of a ft.-lb. for each square inch of the piston of the smaller engine. Therefore the m.e.p. must be proportionately higher to make up for the shorter distance through which it acts, which means of course an earlier valve closure producing more compression.

"The energy stored in the moving parts is

$$E = \frac{WV^2}{2g}$$

where

E = Energy in foot-pounds;
V = Velocity in feet per second;
W = Weight;
g = Acceleration due to gravity (32.16 ft. per sec.).

"If the only difference between the engines were in the length of the stroke; if the diameter of the cylinders, the weight of the piston, crosshead and connecting-rods were the same, all of these factors would be alike for both cases; the energy to be absorbed would be the same, the area upon which the compression pressure acted would be the same, but the distance through which the piston moved against the pressure would be only 1/6 as great in the case of the smaller as in that of the larger engine. In any case

$$\textit{Energy} = \textit{force} \times \textit{distance}$$

$$\left.\begin{matrix}\text{Energy of moving}\\ \text{parts in foot-pounds}\end{matrix}\right\} = \left\{\begin{matrix}\text{Piston area} \times \text{m.e.}\\ \text{p. per sq.in. during}\\ \text{compression}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Distance in feet}\\ \text{through which pis-}\\ \text{ton moves during}\\ \text{compression}\end{matrix}\right.$$

"But, Chief, the crank will bring the parts to rest and start them in the other direction anyway, whether there is compression or not."

"Yes, the crank will bring the parts to rest, and reverse them itself without any compression, but if you depend upon the crank to do it the box will be shoved hard up against the pin in the direction in which the pin has been moving when the crank gets onto the center. Then, when the steam at 150 lb. is let in upon, say a 16-in. piston, you have a force of some 30,000 lb., suddenly jamming the box against the other side of the pin.

"There should be compression enough to gradually take up the energy of the piston and connected parts. The pin should pass from contact with one side of the box to the other, under a balanced pressure (the pressure of compression pushing the piston backward against its own momentum forward). This should happen about as the crank passes the center, perhaps a little before. The amount of compression which will produce this result is greater in a short-stroke than in a long-stroke engine with the same piston speed. The weight of the moving parts is likely to be larger on the slower engine, but the piston area of the smaller is apt to be more than enough less to make up the difference.

"Take it on another tack—

$$\textit{Force} = \textit{mass} \times \textit{acceleration}$$

In this case we are dealing with negative acceleration, or retardation.

"Acceleration is change of velocity per unit of time. In the assumed example the change in velocity in bringing the system to rest is the same in both cases, but the time in which it is done is only 1/6 in the small engine of what it is in the large. Hence, the force applied to the crankpin must be six times as great, and the necessity of a greater compression pressure to balance it."

JUST FOR FUN

Safety Valves Are So Treated Sometimes

A short time ago a man installed a relief valve in the discharge line running from a pump to a closed pressure tank. The relief valve was in place all right, but he still seemed to be perplexed. "What'll I do to the other opening in that relief valve—shall I put a plug in it?"—G. D. Gates, Dubuque, Iowa.

Nearly a "Dead" Short-Circuit

A street-railway inspector was testing some trolley insulators suspected of being defective in their insulating qualities. The test was made in a car barn with a wooden floor by placing each insulator in series with a voltmeter, and from the reading and known resistance of the voltmeter the calculation was made. A file was used to clean the metal work so that a good contact could be made. The inspector held the trolley connecting wire and touched it against the insulators as the case required, while his helper held the ground wire, and being well insulated on the wooden floor, there was little danger. The tests were going along beautifully until the inspector failing to reach the file, the helper picked it up and handed it to him. The next second, both were flat on their backs wondering what had hit them. In passing the file (which had no handle) they had connected themselves across the 500-volt direct-current circuit. The rest of the tests were conducted on the "safety-first" principle.—A. P. Connor, Washington, D. C.

The Boiler Inspector's Dream

The boiler looked strong,
'Twas large and 'twas long,
The steel was remarkably tough.
The seams were all tight,
The rivets looked right,
One could but remark, "Good! Enough!"

I looked everywhere
For flaws here and there,
But never a fault could I find.
"She'll never explode,
No matter what load,"
I said to the fellow behind.

Oh joy! What a sight!
Oh joy! What delight
I had in just drinking her in!
That marvelous shell!
Nobody could tell
How many gold medals she'd win.

Just then my wife cried,
"Wake up! Have you died?
You're one bum inspector," she cussed.
I meekly obeyed;
Went back to my trade,
Inspecting *real* boilers which bust.

W. F. Schaphorst.

New York City.

Density and Volume of Water

By F. R. Low

TEMP. Deg. C.	TEMP. Deg. F.	DENSITY Gr. per Cm.³	DENSITY Lb. per Cu.Ft.	DENSITY Lb. per Gal.	DENSITY Lb. per Cu.In.	VOLUME Cu.Ft. per Lb.	VOLUME Gal. per Lb.	VOLUME Cu.In. per Lb.
0.0	**32.0**	0.99987	62.4201	8.3444	.0361228	.0160205	.119841	27.6833
0.6	**33.0**	0.99990	62.4220	8.3446	.0361238	.0160200	.119838	27.6826
1.0	33.8	0.99993	62.4239	8.3449	.0361249	.0160195	.119834	27.6817
1.1	**34.0**	0.99993	62.4239	8.3449	.0361249	.0160195	.119834	27.6817
1.7	**35.0**	0.99995	62.4251	8.3450	.0361256	.0160192	.119832	27.6812
2.0	35.6	0.99997	62.4264	8.3452	.0361264	.0160189	.119829	27.6806
2.2	**36.0**	0.99997	62.4264	8.3452	.0361264	.0160189	.119829	27.6806
2.8	**37.0**	0.99997	62.4264	8.3452	.0361264	.0160189	.119829	27.6806
3.0	37.4	0.99999	62.4276	8.3454	.0361271	.0160186	.119826	27.6801
3.3	**38.0**	0.99999	62.4276	8.3454	.0361271	.0160186	.119826	27.6801
3.9	**39.0**	0.99999	62.4276	8.3454	.0361271	.0160186	.119826	27.6801
4.0	39.2	1.00000	62.4282	8.3454	.0361275	.0160184	.119826	27.6797
4.4	**40.0**	1.00000	62.4282	8.3454	.0361275	.0160184	.119826	27.6797
5.0	**41.0**	0.99999	62.4276	8.3454	.0361271	.0160186	.119826	27.6801
5.6	**42.0**	0.99998	62.4270	8.3453	.0361267	.0160187	.119828	27.6804
6.0	42.8	0.99997	62.4264	8.3452	.0361264	.0160189	.119829	27.6806
6.1	**43.0**	0.99997	62.4264	8.3452	.0361264	.0160189	.119829	27.6806
6.7	**44.0**	0.99994	62.4245	8.3449	.0361253	.0160194	.119834	27.6814
7.0	44.6	0.99993	62.4239	8.3449	.0361249	.0160195	.119834	27.6817
7.2	**45.0**	0.99992	62.4232	8.3448	.0361246	.0160197	.119835	27.6820
7.8	**46.0**	0.99989	62.4214	8.3445	.0361235	.0160201	.119839	27.6828
8.0	46.4	0.99988	62.4207	8.3444	.0361231	.0160203	.119841	27.6831
8.3	**47.0**	0.99986	62.4195	8.3443	.0361224	.0160206	.119842	27.6837
8.9	**48.0**	0.99982	62.4170	8.3440	.0361210	.0160213	.119847	27.6847
9.0	48.2	0.99981	62.4164	8.3439	.0361206	.0160214	.119848	27.6850
9.4	**49.0**	0.99978	62.4145	8.3436	.0361195	.0160219	.119852	27.6863
10.0	**50.0**	0.99973	62.4114	8.3432	.0361177	.0160227	.119858	27.6873
10.6	**51.0**	0.99967	62.4076	8.3427	.0361155	.0160237	.119865	27.6889
11.0	51.8	0.99963	62.4051	8.3424	.0361141	.0160243	.119870	27.6900
11.1	**52.0**	0.99962	62.4045	8.3423	.0361137	.0160245	.119871	27.6903
11.7	**53.0**	0.99955	62.4001	8.3417	.0361112	.0160256	.119880	27.6922
12.0	53.6	0.99952	62.3983	8.3414	.0361101	.0160261	.119884	27.6931
12.2	**54.0**	0.99950	62.3970	8.3413	.0361094	.0160264	.119885	27.6936
12.8	**55.0**	0.99942	62.3920	8.3406	.0361065	.0160277	.119895	27.6958
13.0	55.4	0.99940	62.3908	8.3404	.0361058	.0160280	.119898	27.6964
13.3	**56.0**	0.99936	62.3883	8.3401	.0361053	.0160286	.119903	27.6968
13.9	**57.0**	0.99928	62.3833	8.3394	.0361014	.0160299	.119913	27.6998
14.0	57.2	0.99927	62.3827	8.3393	.0361011	.0160301	.119914	27.7000
14.4	58.0	0.99921	62.3789	8.3388	.0360989	.0160311	.119921	27.7017
15.0	**59.0**	0.99913	62.3739	8.3382	.0360960	.0160323	.119930	27.7039
15.6	**60.0**	0.99903	62.3677	8.3373	.0360924	.0160339	.119943	27.7067
16.0	60.8	0.99897	62.3639	8.3368	.0360902	.0160349	.119948	27.7083
16.1	**61.0**	0.99895	62.3627	8.3367	.0360895	.0160352	.119952	27.7089
16.7	**62.0**	0.99885	62.3564	8.3358	.0360859	.0160368	.119964	27.7117
17.0	62.6	0.99880	62.3533	8.3354	.0360841	.0160376	.119970	27.7130
17.2	**63.0**	0.99876	62.3508	8.3351	.0360827	.0160383	.119975	27.7141
17.8	**64.0**	0.99866	62.3446	8.3343	.0360790	.0160399	.119986	27.7170
18.0	64.4	0.99862	62.3421	8.3339	.0360776	.0160405	.119992	27.7180
18.3	**65.0**	0.99856	62.3383	8.3334	.0360754	.0160415	.119999	27.7197
18.9	**66.0**	0.99845	62.3315	8.3325	.0360715	.0160433	.120012	27.7227
19.0	66.2	0.99843	62.3302	8.3323	.0360707	.0160436	.120015	27.7233
19.4	**67.0**	0.99835	62.3252	8.3317	.0360678	.0160449	.120024	27.7256
20.0	**68.0**	0.99823	62.3177	8.3307	.0360635	.0160468	.120038	27.7289
20.6	**69.0**	0.99810	62.3096	8.3296	.0360588	.0160489	.120054	27.7325
21.0	69.8	0.99802	62.3046	8.3289	.0360559	.0160502	.120064	27.7347
21.1	**70.0**	0.99800	62.3034	8.3288	.0360552	.0160505	.120065	27.7353
21.7	**71.0**	0.99787	62.2953	8.3277	.0360505	.0160526	.120081	27.7389
22.0	71.6	0.99780	62.2909	8.3271	.0360480	.0160537	.120090	27.7408
22.2	**72.0**	0.99775	62.2878	8.3267	.0360462	.0160545	.120096	27.7422
22.8	**73.0**	0.99761	62.2790	8.3255	.0360411	.0160568	.120113	27.7461
23.0	73.4	0.99756	62.2759	8.3251	.0360393	.0160576	.120119	27.7475
23.3	**74.0**	0.99749	62.2715	8.3245	.0360368	.0160587	.120127	27.7494
23.9	**75.0**	0.99734	62.2622	8.3232	.0360314	.0160611	.120146	27.7536
24.0	75.2	0.99732	62.2609	8.3231	.0360306	.0160614	.120148	27.7542
24.4	**76.0**	0.99722	62.2547	8.3222	.0360270	.0160630	.120161	27.7570
25.0	**77.0**	0.99707	62.2453	8.3210	.0360216	.0160655	.120178	27.7611
25.6	**78.0**	0.99691	62.2353	8.3197	.0360158	.0160681	.120197	27.7656
26.0	78.8	0.99681	62.2291	8.3188	.0360122	.0160697	.120210	27.7684
26.1	**79.0**	0.99678	62.2272	8.3186	.0360111	.0160701	.120213	27.7692
26.7	**80.0**	0.99662	62.2172	8.3172	.0360053	.0160727	.120233	27.7737
27.0	80.6	0.99654	62.2122	8.3166	.0360025	.0160740	.120241	27.7758
27.2	**81.0**	0.99648	62.2085	8.3161	.0360003	.0160750	.120249	27.7775
27.8	**82.0**	0.99632	62.1985	8.3147	.0359945	.0160776	.120269	27.7820
28.0	82.4	0.99626	62.1948	8.3142	.0359923	.0160785	.120276	27.7837
28.3	**83.0**	0.99617	62.1891	8.3135	.0359891	.0160800	.120286	27.7862
28.9	**84.0**	0.99600	62.1785	8.3121	.0359829	.0160827	.120307	27.7910
29.0	84.2	0.99597	62.1767	8.3118	.0359819	.0160832	.120311	27.7918
29.4	**85.0**	0.99585	62.1692	8.3108	.0359775	.0160851	.120325	27.7951
30.0	**86.0**	0.99567	62.1579	8.3093	.0359710	.0160881	.120347	27.8002
30.6	**87.0**	0.99549	62.1467	8.3078	.0359645	.0160910	.120369	27.8052
31.0	87.8	0.99537	62.1392	8.3068	.0359602	.0160929	.120383	27.8085
31.1	**88.0**	0.99534	62.1373	8.3066	.0359591	.0160934	.120386	27.8094
31.7	**89.0**	0.99515	62.1255	8.3050	.0359522	.0160964	.120409	27.8147
32.0	89.6	0.99505	62.1192	8.3041	.0359486	.0160981	.120422	27.8175
32.2	**90.0**	0.99499	62.1155	8.3036	.0359465	.0160990	.120430	27.8191
32.8	**91.0**	0.99479	62.1030	8.3020	.0359392	.0161023	.120453	27.8248
33.0	91.4	0.99473	62.0992	8.3015	.0359371	.0161033	.120460	27.8264
33.3	**92.0**	0.99463	62.0930	8.3006	.0359334	.0161049	.120473	27.8293
33.9	**93.0**	0.99443	62.0805	8.2990	.0359262	.0161081	.120496	27.8348
34.0	93.2	0.99440	62.0786	8.2987	.0359251	.0161086	.120501	27.8357
34.4	**94.0**	0.99426	62.0699	8.2975	.0359201	.0161116	.120518	27.8396
35.0	**95.0**	0.99406	62.0574	8.2959	.0359129	.0161141	.120541	27.8451
35.6	**96.0**	0.99385	62.0443	8.2941	.0359053	.0161175	.120568	27.8510
36.0	96.8	0.99371	62.0356	8.2929	.0359002	.0161198	.120585	27.8550
36.1	**97.0**	0.99367	62.0331	8.2926	.0358988	.0161204	.120589	27.8561
36.7	**98.0**	0.99346	62.0200	8.2909	.0358912	.0161238	.120614	27.8620
37.0	98.6	0.99336	62.0137	8.2900	.0358876	.0161255	.120627	27.8648
37.2	**99.0**	0.99329	62.0093	8.2894	.0358850	.0161266	.120636	27.8668
37.8	**100.0**	0.99306	61.9950	8.2875	.0358767	.0161303	.120664	27.8732
38.0	100.4	0.99299	61.9906	8.2869	.0358742	.0161315	.120672	27.8752
38.3	**101.0**	0.99288	61.9837	8.2860	.0358702	.0161333	.120685	27.8783
38.9	**102.0**	0.99266	61.9700	8.2842	.0358623	.0161368	.120712	27.8844
39.0	102.2	0.99262	61.9675	8.2839	.0358608	.0161375	.120716	27.8856
39.4	**103.0**	0.99247	61.9582	8.2826	.0358554	.0161399	.120735	27.8898
40.0	**104.0**	0.99224	61.9438	8.2807	.0358471	.0161437	.120763	27.8963
40.6	**105.0**	0.99201	61.9294	8.2788	.0358388	.0161474	.120790	27.9027
41.0	105.8	0.99186	61.9201	8.2775	.0358334	.0161498	.120809	27.9069
41.1	**106.0**	0.99182	61.9176	8.2772	.0358319	.0161505	.120814	27.9081
41.7	**107.0**	0.99159	61.9032	8.2753	.0358236	.0161543	.120842	27.9146
42.0	107.6	0.99147	61.8957	8.2743	.0358193	.0161562	.120856	27.9179
42.2	**108.0**	0.99139	61.8907	8.2736	.0358164	.0161575	.120866	27.9202
42.8	**109.0**	0.99115	61.8757	8.2716	.0358077	.0161614	.120896	27.9270
43.0	109.4	0.99107	61.8708	8.2709	.0358048	.0161627	.120906	27.9292
43.3	**110.0**	0.99095	61.8633	8.2699	.0358005	.0161647	.120920	27.9326
43.9	**111.0**	0.99070	61.8477	8.2678	.0357915	.0161688	.120951	27.9396
44.0	111.2	0.99066	61.8452	8.2675	.0357900	.0161694	.120956	27.9408
44.4	**112.0**	0.99049	61.8345	8.2661	.0357839	.0161722	.120976	27.9455
45.0	**113.0**	0.99024	61.8189	8.2640	.0357748	.0161763	.121007	27.9526
45.6	**114.0**	0.98999	61.8033	8.2619	.0357658	.0161804	.121038	27.9597
46.0	114.8	0.98982	61.7927	8.2605	.0357597	.0161831	.121058	27.9644
46.1	**115.0**	0.98978	61.7802	8.2602	.0357582	.0161864	.121062	27.9656
46.7	**116.0**	0.98953	61.7746	8.2581	.0357492	.0161879	.121093	27.9727
47.0	116.6	0.98940	61.7665	8.2570	.0357445	.0161900	.121109	27.9763
47.2	**117.0**	0.98931	61.7609	8.2562	.0357413	.0161915	.121121	27.9788
47.8	**118.0**	0.98905	61.7446	8.2541	.0357319	.0161957	.121152	27.9862
48.0	118.4	0.98896	61.7390	8.2533	.0357286	.0161972	.121164	27.9888
48.3	**119.0**	0.98883	61.7309	8.2522	.0357239	.0161993	.121180	27.9925
48.9	**120.0**	0.98856	61.7141	8.2500	.0357142	.0162038	.121212	28.0001
49.0	120.2	0.98852	61.7116	8.2496	.0357127	.0162044	.121218	28.0012
49.4	**121.0**	0.98834	61.7003	8.2481	.0357062	.0162074	.121240	28.0063
50.0	**122.0**	0.98807	61.6835	8.2459	.0356965	.0162118	.121272	28.0140
50.6	**123.0**	0.98780	61.6666	8.2436	.0356867	.0162162	.121306	28.0216
51.0	123.8	0.98762	61.6554	8.2421	.0356802	.0162192	.121328	28.0267
51.1	**124.0**	0.98757	61.6523	8.2417	.0356784	.0162200	.121334	28.0282
51.7	**125.0**	0.98729	61.6348	8.2394	.0356683	.0162246	.121368	28.0361
52.0	125.6	0.98715	61.6260	8.2382	.0356632	.0162269	.121386	28.0401
52.2	**126.0**	0.98706	61.6204	8.2375	.0356600	.0162284	.121396	28.0426
52.8	**127.0**	0.98678	61.6029	8.2351	.0356498	.0162330	.121431	28.0506
53.0	127.4	0.98669	61.5973	8.2344	.0356466	.0162345	.121442	28.0532
53.3	**128.0**	0.98655	61.5886	8.2332	.0356415	.0162368	.121459	28.0572
53.9	**129.0**	0.98626	61.5705	8.2308	.0356311	.0162415	.121495	28.0654
54.0	129.2	0.98621	61.5674	8.2304	.0356293	.0162424	.121501	28.0668
54.4	**130.0**	0.98602	61.5555	8.2288	.0356224	.0162455	.121524	28.0722
55.0	**131.0**	0.98573	61.5374	8.2264	.0356119	.0162503	.121560	28.0805
55.6	**132.0**	0.98544	61.5193	8.2239	.0356014	.0162551	.121597	28.0888
56.0	132.8	0.98524	61.5068	8.2223	.0355942	.0162584	.121620	28.0945
56.1	**133.0**	0.98519	61.5037	8.2218	.0355924	.0162592	.121628	28.0959
56.7	**134.0**	0.98492	61.4868	8.2196	.0355827	.0162637	.121660	28.1035
57.0	134.6	0.98478	61.4781	8.2184	.0355776	.0162660	.121678	28.1076
57.2	**135.0**	0.98467	61.4712	8.2175	.0355736	.0162678	.121692	28.1107
57.8	**136.0**	0.98436	61.4519	8.2149	.0355624	.0162729	.121730	28.1196
58.0	136.4	0.98425	61.4450	8.2140	.0355584	.0162747	.121743	28.1228
58.3	**137.0**	0.98410	61.4356	8.2127	.0355530	.0162772	.121763	28.1270
58.9	**138.0**	0.98380	61.4169	8.2102	.0355422	.0162822	.121800	28.1356
59.0	138.2	0.98375	61.4138	8.2098	.0355404	.0162830	.121806	28.1370
59.4	**139.0**	0.98355	**61.4013**	8.2082	.0355332	.0162863	.121829	28.1427
60.0	**140.0**	0.98324	61.3819	8.2056	.0355220	.0162914	.121868	28.1516
60.6	**141.0**	0.98293	61.3626	8.2030	.0355108	.0162966	.121907	28.1604
61.0	141.8	0.98272	61.3495	8.2012	.0355032	.0163001	.121933	28.1665
61.1	**142.0**	0.98267	61.3464	8.2008	.0355014	.0163009	.121939	28.1679
61.7	**143.0**	0.98236	61.3270	8.1982	.0354902	.0163060	.121978	28.1768
62.0	143.6	0.98220	61.3170	8.1969	.0354844	.0163087	.121997	28.1814
62.2	**144.0**	0.98209	61.3101	8.1960	.0354804	.0163105	.122011	28.1846
62.8	**145.0**	0.98178	61.2908	8.1934	.0354692	.0163157	.122049	28.1935
63.0	145.4	0.98167	61.2839	8.1925	.0354652	.0163175	.122063	28.1967
63.3	**146.0**	0.98151	61.2739	8.1911	.0354595	.0163202	.122084	28.2012
63.9	**147.0**	0.98118	61.2533	8.1884	.0354475	.0163257	.122124	28.2107
64.0	147.2	0.98113	61.2502	8.1880	.0354457	.0163265	.122130	28.2122
64.4	**148.0**	0.98091	61.2365	8.1861	.0354378	.0163301	.122158	28.2185
65.0	**149.0**	0.98059	61.2165	8.1835	.0354262	.0163355	.122197	28.2277
65.6	**150.0**	0.98027	61.1965	8.1808	.0354147	.0163408	.122237	28.2369
66.0	150.8	0.98005	61.1828	8.1790	.0354067	.0163445	.122264	28.2432
66.1	**151.0**	0.98000	61.1797	8.1785	.0354049	.0163453	.122272	28.2447
66.7	**152.0**	0.97967	61.1591	8.1758	.0353930	.0163508	.122312	28.2542
67.0	152.6	0.97950	61.1485	8.1744	.0353868	.0163536	.122333	28.2591
67.2	**153.0**	0.97939	61.1416	8.1734	.0353829	.0163555	.122348	28.2622
67.8	**154.0**	0.97905	61.1204	8.1706	.0353706	.0163611	.122390	28.2721
68.0	154.4	0.97894	61.1135	8.1697	.0353666	.0163630	.122404	28.2753
68.3	**155.0**	0.97877	61.1029	8.1683	.0353605	.0163658	.122424	28.2801
68.9	**156.0**	0.97844	61.0823	8.1655	.0353485	.0163714	.122466	28.2897
69.0	156.2	0.97838	61.0785	8.1650	.0353464	.0163724	.122474	28.2914
69.4	**157.0**	0.97815	61.0642	8.1631	.0353381	.0163762	.122502	28.2981
70.0	**158.0**	0.97781	61.0430	8.1603	.0353258	.0163819	.122545	28.3079
70.6	**159.0**	0.97746	61.0211	8.1573	.0353131	.0163878	.122590	28.3181
71.0	159.8	0.97723	61.0067	8.1554	.0353048	.0163916	.122618	28.3248
71.1	**160.0**	0.97717	61.0030	8.1549	.0353027	.0163926	.122626	28.3264
71.7	**161.0**	0.97683	60.9818	8.1521	.0352904	.0163983	.122668	28.3363
72.0	161.6	0.97666	60.9712	8.1507	.0352842	.0164012	.122689	28.3413
72.2	**162.0**	0.97654	60.9637	8.1497	.0352799	.0164032	.122704	28.3448
72.8	**163.0**	0.97619	60.9418	8.1467	.0352673	.0164091	.122749	28.3549
73.0	163.4	0.97607	60.9343	8.1457	.0352629	.0164111	.122764	28.3584
73.3	**164.0**	0.97589	60.9231	8.1442	.0352564	.0164141	.122787	28.3636
73.9	**165.0**	0.97554	60.9012	8.1413	.0352438	.0164200	.122831	28.3738
74.0	165.2	0.97548	60.8975	8.1408	.0352416	.0164210	.122838	28.3756
74.4	**166.0**	0.97524	60.8825	8.1388	.0352329	.0164251	.122868	28.3826
75.0	**167.0**	0.97489	60.8607	8.1359	.0352203	.0164310	.122912	28.3927
75.6	**168.0**	0.97452	60.8376	8.1328	.0352069	.0164372	.122959	28.4035
76.0	168.8	0.97428	60.8226	8.1308	.0351983	.0164413	.122989	28.4105
76.1	**169.0**	0.97422	60.8188	8.1303	.0351961	.0164423	.122997	28.4122
76.7	**170.0**	0.97386	60.7964	8.1273	.0351831	.0164483	.123042	28.4227

TEMP. Deg. C.	TEMP. Deg. F.	DENSITY Gr. per Cm.³	DENSITY Lb. per Cu.Ft.	DENSITY Lb. per Gal.	DENSITY Lb. per Cu.In.	VOLUME Cu.Ft. per Lb.	VOLUME Gal. per Lb.	VOLUME Cu.In. per Lb.
77.0	**170.6**	0.97368	60.7851	8.1258	.0351766	.0164514	.123065	28.4280
77.2	**171.0**	0.97356	60.7776	8.1248	.0351722	.0164534	.123080	28.4315
77.8	**172.0**	0.97319	60.7545	8.1217	.0351589	.0164597	.123127	28.4423
78.0	172.4	0.97307	60.7470	8.1207	.0351545	.0164617	.123142	28.4459
78.3	**173.0**	0.97288	60.7352	8.1191	.0351477	.0164649	.123166	28.4514
78.9	**174.0**	0.97251	60.7121	8.1160	.0351343	.0164712	.123213	28.4622
79.0	174.2	0.97245	60.7083	8.1155	.0351321	.0164722	.123221	28.4640
79.4	**175.0**	0.97220	60.6927	8.1134	.0351231	.0164764	.123253	28.4713
80.0	**176.0**	0.97183	60.6696	8.1104	.0351097	.0164827	.123298	28.4822
80.6	**177.0**	0.97145	60.6459	8.1072	.0350960	.0164892	.123345	28.4933
81.0	177.8	0.97120	60.6303	8.1051	.0350870	.0164934	.123379	28.5006
81.1	**178.0**	0.97114	60.6266	8.1046	.0350848	.0164944	.123387	28.5024
81.7	**179.0**	0.97076	60.6028	8.1014	.0350711	.0165009	.123435	28.5135
82.0	179.6	0.97057	60.5910	8.0998	.0350642	.0165041	.123460	28.5191
82.2	**180.0**	0.97044	60.5829	8.0988	.0350595	.0165063	.123475	28.5229
82.8	**181.0**	0.97007	60.5598	8.0957	.0350462	.0165126	.123522	28.5338
83.0	181.4	0.96994	60.5516	8.0946	.0350415	.0165148	.123539	28.5376
83.3	**182.0**	0.96975	60.5398	8.0930	.0350346	.0165181	.123563	28.5432
83.9	**183.0**	0.96936	60.5154	8.0897	.0350205	.0165247	.123614	28.5547
84.0	183.2	0.96930	60.5117	8.0892	.0350183	.0165257	.123622	28.5565
84.4	**184.0**	0.96904	60.4955	8.0871	.0350089	.0165302	.123654	28.5642
85.0	**185.0**	0.96865	60.4711	8.0838	.0349949	.0165368	.123701	28.5756
85.6	**186.0**	0.96826	60.4461	8.0806	.0349808	.0165437	.123753	28.5871
86.0	186.8	0.96800	60 4305	8.0784	.0349714	.0165479	.123787	28.5948
86.1	**187.0**	0.96793	60.4262	8.0778	.0349688	.0165491	.123796	28.5969
86.7	**188.0**	0.96754	60.4018	8.0745	.0349548	.0165558	.123847	28.6084
87.0	188.6	0.96734	60.3893	8.0729	.0349475	.0165592	.123871	28.6144
87.2	**189.0**	0.96721	60.3812	8.0718	.0349428	.0165614	.123888	28.6182
87.8	**190.0**	0.96681	60.3562	8.0685	.0349284	.0165683	.123939	28.6300
88.0	190.4	0.96668	60.3481	8.0674	.0349237	.0165705	.123956	28.6339
88.3	**191.0**	0.96648	60.3356	8.0657	.0349165	.0165740	.123982	28.6398
88.9	**192.0**	0.96608	60.3107	8.0624	.0349020	.0165808	.124033	28.6517
89.0	192.2	0.96601	60.3063	8.0618	.0348995	.0165820	.124042	28.6537
89.4	**193.0**	0.96574	60.2894	8.0595	.0348897	.0165867	.124077	28.6618
90.0	**194.0**	0.96534	60.2645	8.0562	.0348753	.0165935	.124128	28.6736
90.6	**195.0**	0.96494	60.2395	8.0529	.0348608	.0166004	.124179	28.6853
91.0	195.8	0.96467	60.2226	8.0506	.0348511	.0166051	.124214	28.6935
91.1	**196.0**	0.96460	60.2183	8.0500	.0348485	.0166062	.124224	28.6956
91.7	**197.0**	0.96419	60.1927	8.0466	.0348337	.0166133	.124276	28.7078
92.0	197.6	0.96399	60.1802	8.0449	.0348265	.0166168	.124302	28.7138
92.2	**198.0**	0.96385	60.1715	8.0438	.0348214	.0166192	.124319	28.7180
92.8	**199.0**	0.96344	60.1459	8.0403	.0348066	.0166262	.124373	28.7302
93.0	199.4	0.96330	60.1371	8.0392	.0348016	.0166287	.124390	28.7343
93.3	**200.0**	0.96309	60.1240	8.0374	.0347940	.0166323	.124418	28.7406
93.9	**201.0**	0.96268	60.0984	8.0340	.0347792	.0166394	.124471	28.7528
94.0	201.2	0.96261	60.0940	8.0334	.0347766	.0166406	.124480	28.7550
94.4	**202.0**	0.96233	60.0766	8.0311	.0347665	.0166454	.124516	28.7633
95.0	**203.0**	0.96192	60.0510	8.0276	.0347517	.0166525	.124570	28.7756
95.6	**204.0**	0.96150	60.0258	8.0241	.0347365	.0166595	.124625	28.7882
96.0	204.8	0.96122	60.0073	8.0218	.0347264	.0166646	.124660	28.7965
96.1	**205.0**	0.96115	60.0029	8.0212	.0347239	.0166659	.124670	28.7986
96.7	**206.0**	0.96072	59.9761	8.0176	.0347084	.0166733	.124726	28.8115
97.0	206.6	0.96051	59.9629	8.0159	.0347008	.0166770	.124752	28.8178
97.2	**207.0**	0.96037	59.9542	8.0147	.0346957	.0166794	.124771	28.8220
97.8	**208.0**	0.95995	59.9280	8.0112	.0346805	.0166867	.124825	28.8346
98.0	208.4	0.95981	59.9192	8.0100	.0346755	.0166891	.124844	28.8388
98.3	**209.0**	0.95959	59.9055	8.0082	.0346675	.0166930	.124872	28.8455
98.9	**210.0**	0.95916	59.8787	8.0046	.0346520	.0167004	.124928	28.8584
99.0	210.2	0.95909	59.8743	8.0040	.0346495	.0167017	.124938	28.8604
99.4	**211.0**	0.95881	59.8568	8.0017	.0346394	.0167065	.124973	28.8689
100.0	**212.0**	0.95838	59.8300	7.9981	.0346238	.0167140	.125030	28.8819
100.6	**213.0**	0.95794	59.8025	7.9944	.0346079	.0167217	.125088	28.8951
101.0	213.8	0.95765	59.7844	7.9920	.0345975	.0167268	.125125	28.9038
101.1	**214.0**	0.95758	59.7800	7.9914	.0345949	.0167280	.125135	28.9060
101.7	**215.0**	0.95715	59.7532	7.9878	.0345794	.0167355	.125191	28.9190
102.0	215.6	0.95693	59.7395	7.9860	.0345714	.0167393	.125219	28.9256
102.2	**216.0**	0.95679	59.7307	7.9848	.0345664	.0167418	.125238	28.9298
102.8	**217.0**	0.95636	59.7039	7.9812	.0345509	.0167493	.125294	28.9428
103.0	217.4	0.95622	59.6951	7.9801	.0345458	.0167518	.125312	28.9471
103.3	**218.0**	0.95601	59.6820	7.9783	.0345382	.0167555	.125340	28.9534

The above table, giving the weight per cubic foot, per cubic inch and per gallon, and the number of cubic feet, cubic inches and gallons per pound of water at different temperatures from the freezing to the boiling points at atmospheric pressure, has been computed from the table in Circular No. 19 of the U. S. Bureau of Standards, which gives the density in grams per milliliter for even degrees Centrigrade only. This table is based upon the work of M. Thiesen, as published in the "Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt," 4, No. 1, 1904, and is considered by the Bureau the latest and best information upon the subject.

To find the pressure in pounds per square inch corresponding to a given head, multiply the weight in pounds per cubic inch by 12 and by the given head in feet.

To find the head required to produce a given pressure, multiply the given pressure in pounds per square inch by the cubic inches per pound, and divide by 12.

Record System in a Smoke Inspector's Office

By Martin A. Rooney*

The smoke-inspection department of a large city deals with a mass of detail. The performance of each stack must be watched and recorded, and data relative to the construction and operation of each plant filed. The office system employed in doing this is of interest, as with wrong methods either a large number of important matters will be lost sight of or too much time will be given to matters of little or no value. The system described here has been in use in the office of a city of 150,000 inhabitants for over three years with highly satisfactory results.

Each plant has had a number assigned to it and a folder having the name of the plant and the number is made out and filed numerically in a letter file. This folder (standard letter size) is used to hold all letters, data, etc., referring to this plant. Large envelopes labeled like the folders are arranged numerically in a separate file and filled with drawings, sketches, etc., relating to the plant. The card, Fig. 1, containing information as to number and size of boilers, permits, etc., is filed alphabetically. The file containing these cards forms an alphabetical index for the system and gives information about the plants in readily accessible form. The card, Fig. 2, is a record of stack observations and is filed.

Books with pages ruled as in Fig. 3 are used by the stack observers for recording the smoke from stationary stacks and locomotives. On the left-hand page all information necessary to identify the stack and the conditions under which the observation is made are recorded. Each space on the right-hand page represents one-half minute. The observer in reading a stack places in the

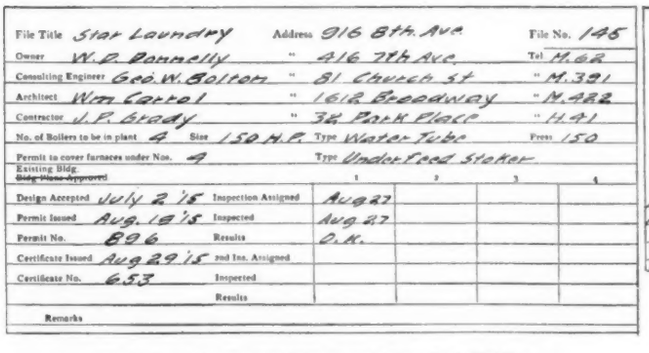

File Title Star Laundry
Address 916 8th Ave
File No. 145
Owner W. P. Donnelly " 416 7th Ave Tel M.62
Consulting Engineer Geo. W. Bolton " 81 Church St " M.391
Architect Wm. Carrol " 1612 Broadway " M.482
Contractor J. P. Brady " 32 Park Place " M.91
No. of Boilers to be in plant 4 Size 150 H.P. Type Water Tube Press 150
Permit to cover furnaces under Nos. 4 Type Underfeed Stoker
Existing Bldg.
Bldg. Plans Approved
Design Accepted July 2 '15 Inspection Assigned Aug 27
Permit Issued Aug. 10 '15 Inspected Aug 27
Permit No. 896 Results O.K.
Certificate Issued Aug 29 '15 2nd Ins. Assigned
Certificate No. 653 Inspected
Results
Remarks

FIG. 1. INFORMATION CARD, INDEXED

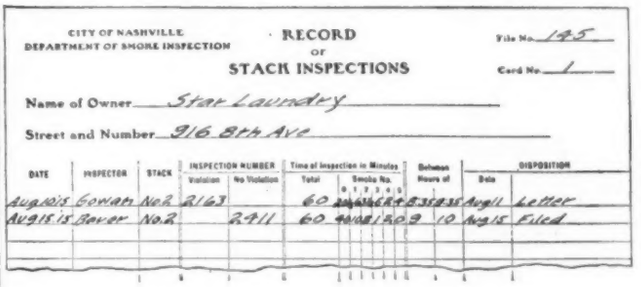


FIG. 2. STACK RECORD CARD

*Smoke Inspector, Nashville, Tenn.

space corresponding to each half-minute the Ringlemann number of the smoke emitted during that half-minute. For instance, in Fig. 3 no smoke was made for the first three minutes, then No. 1 smoke was made for one-

Serial No. 2163
File No. 145
Address Star Laundry
Date Aug. 10 1915
Point of Observation City Hall Roof
Observation began 8:35 A. M.
" ended 9:35 A. M.
Weather Clear
Wind North
No. of Stacks 2
Description Steel
Report Covers North. NOR.
Railroad
Locomotive No.
Location
Service
Cleaning Fire
Building
Pops
Blower
Running
Standing

MINUTES			MINUTES	
1			31	
2			32	
3			33	
4	1	3	34	
5	3	5	35	
6	5	5	36	
7	4	2	37	
8	1	1	38	
9	1		39	
10			40	
11			41	1 1
12			42	1 1
13			43	2 2
14			44	2 2
15			45	3 3
16			46	3 3
17			47	4 4
18			48	5 5
19			49	3 3
20	5	5	50	1 1
21	5	4	51	
22	3	3	52	
23	2	2	53	
24	1	1	54	
25			55	
26			56	
27			57	
28			58	
29			59	
30			60	

FIG. 3. PAGE FROM STACK OBSERVATION BOOK CARRIED BY INSPECTOR

half minute, No. 3 for one minute, No. 5 for one and one-half minutes, etc. Using one of these books a man can easily read twenty stacks at a time. Each stack observation is given a serial number.

The readings taken on these books are transferred to the chart, Fig. 4, and filed numerically according to

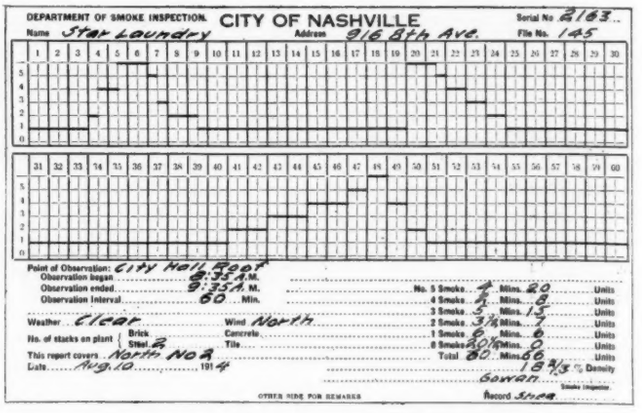


FIG. 4. SMOKE CHART, STATIONARY STACK

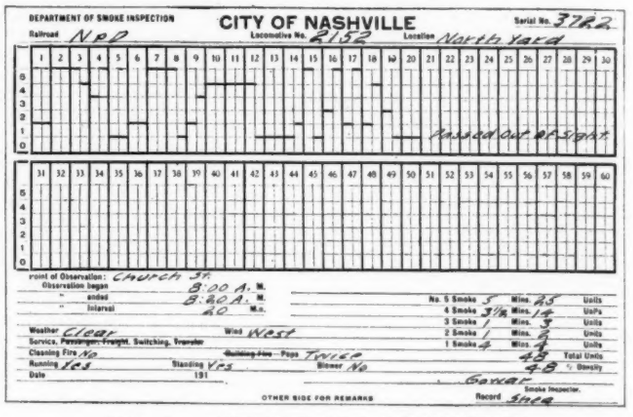


FIG. 5. SMOKE CHART, LOCOMOTIVE

their serial number. A green chart (Fig. 5) is used for locomotive observations.

Before a permit is issued application must be made on a printed form provided with blanks for furnishing full information in regard to boilers, fuel, load, etc., in the proposed plant. The permit and stub used are as shown in Fig. 6.

Permit No 839
File No 145
Application No. 791
Issued Aug 19 1915
To Star Laundry Co
916 8th Ave
Certificate 653

CITY OF NASHVILLE
DEPARTMENT OF SMOKE INSPECTION
MARTIN A. ROONEY, Chief Smoke Inspector.

Permit No. 839
File No. 145

PERMIT FOR CONSTRUCTION.

Nashville, Tenn. Aug 19 1915

Permission is hereby granted to Star Laundry Co. Owner to ~~reconstruct~~ construct Four Mechanical Stokers new in a ~~existing~~ plant located at 916 8th Ave in accordance with plans and specifications on file in the office of the Smoke Inspection Department and numbered 145

Application for permit made by W. D. Donnelly

Address Manager

special combustion device _____ fuel to be used Soft Coal

This permit is revocable at any time by the Department of Smoke Inspection.

Nothing contained herein is to be considered a waiver of liability in the case of the infraction of any City ordinance.

This is not a Certificate allowing operation
Keep this permit at the building

CHIEF SMOKE INSPECTOR.

FIG. 6. PERMIT ISSUED BY THE NASHVILLE, TENN., SMOKE DEPARTMENT

Initial and Operating Costs of Large Ice Plants

By Robert P. Kehoe*

So many ice-making plants of large capacity are now in operation and so many new ones are often projected that a compilation of initial and operating costs will be of interest. The tabulation published herewith offers an opportunity to study the relations between the three principal types of plants in five sizes, ranging from 100 to 500 tons' capacity per day of 24 hr.

No consideration is given to cost of property, which of course will vary with the location. If desirable, an amount to cover this item may be added to the investment in each case in order to figure the percentage of possible profit. This will have no effect on the operating cost unless interest is added in the estimate of yearly expense. In this event the interest on the total amount of borrowed money may be figured in. At any rate the comparisons are true, and if the cost of labor and that of fuel are adjusted to suit a particular locality, the table will be a correct guide in the determination of the advantageous kind of plant to install.

The usual refinements advisable for large distilled-water plants have been covered in the first costs of the steam-driven plants. These refinements include evaporators and automatic stokers. An average economy of nine tons of ice per ton of coal has been assumed. This may be increased to ten or more tons per ton of coal under ideal conditions, but the usual working basis will probably not average more than nine to one.

In the raw-water plants the standard drop-tube system is the basis. This may be either the multiple or double drop-tube type according to the latest practice in up-to-date successful installations. If a fine quality of ice is required, the Beals system may be added, in which case the first cost and the depreciation will increase, but the labor cost will be reduced. The Beals process requires no more labor than the regular distilled-water system, while in drop-tube plants the tubes have to be watched and the core water replaced at the proper time.

The product of drop-tube systems with properly filtered water is always good, unless water of unusual characteristics is used. The refilled core water, which is frozen without agitation, produces a core similar to distilled-water ice. The slight odor which can often be detected in the latter when broken up is rarely found in raw-water ice. The Beals system considerably reduces the core, which makes almost the entire block transparent.

Raw-water ice is surely gaining in favor, and operators are also perfecting the method for handling these plants to such a degree that no trouble is now experienced in turning out a first-class marketable product. The installation of plants of 400 and 200 tons' daily capacity in New York City marks the final stage in the universal approval of this process. As both plants are driven by oil engines, the success of this type of motive power for ice manufacture is also indicated. There are now many oil-engine-driven plants of all sizes.

The price of oil has been taken as 3½c. per gal. In many sections a lower price is obtainable. It is advisable to adopt a type and make of engine that will burn the heaviest and cheapest grades of fuel oil.

*Engineer, De La Vergne Machine Co., New York.

INVESTMENT, DAILY AND YEARLY COST OF OPERATION OF LARGE ICE PLANTS

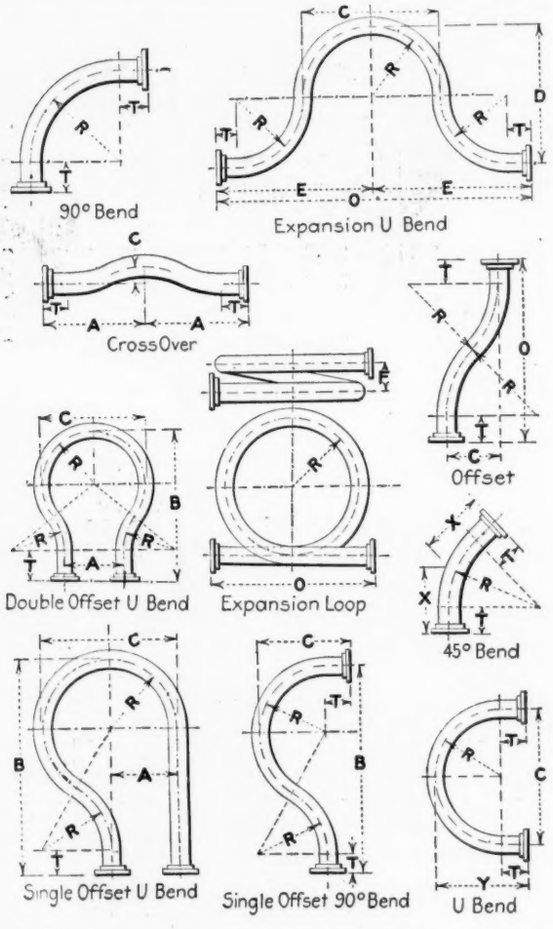
Capacity in tons of ice per 24 hr.	100 Tons Raw Water			200 Tons Raw Water			300 Tons Raw Water			400 Tons Raw Water			500 Tons Raw Water		
Type of plant (all 300-lb. cans)	Distilled Water Compound Condensing Steam Engines	Electric Motors	Oil Engines	Distilled Water Compound Condensing Steam Engines	Electric Motors	Oil Engines	Distilled Water Compound Condensing Steam Engines	Electric Motors	Oil Engines	Distilled Water Compound Condensing Steam Engines	Electric Motors	Oil Engines	Distilled Water Compound Condensing Steam Engines	Electric Motors	Oil Engines
Motive power															
Investment:															
Mechanical equipment complete	$62,000	$52,000	$70,000	$119,000	$99,000	$135,000	$171,000	$141,000	$195,000	$218,000	$178,000	$250,000	$260,000	$210,000	$300,000
Building	37,500	35,000	35,000	65,000	60,000	60,000	95,000	88,000	88,000	120,000	111,000	111,000	150,000	140,000	140,000
Total investment (excluding land)	$99,500	$87,000	$105,000	$184,000	$159,000	$195,000	$266,000	$229,000	$283,000	$338,000	$289,000	$361,000	$410,000	$350,000	$440,000
Daily Operating Expense:															
Chief engineer	$6.00	$5.00	$6.00	$7.00	$6.00	$7.00	$7.50	$6.50	$7.50	$8.00	$7.00	$8.00	$9.00	$8.00	$9.00
Assistant engineers (1)	3.50	3.50	3.50	4.00	4.00	4.00	7.00	7.00	7.00	(2) 8.00	8.00	8.00	(2) 10.00	10.00	10.00
(2)	4.00	4.00	4.00	4.00	4.00	4.00	(4) 8.00	8.00	8.00	(4) 8.00	8.00	8.00	(4) 8.00	8.00	8.00
Oilers (2)	4.00	...	...	(2) 4.50	...	...	(2) 5.00	...	...	(2) 6.00	...	...	(2) 7.00	...	...
Firemen (2)	4.00	...	...	(2) 4.50	...	...	(2) 5.00	...	...	(2) 6.00	...	...	(2) 7.00	...	...
Tankmen (4)	8.00	(6) 12.00	12.00	(8) 16.00	(12) 24.00	24.00	(10) 20.00	(15) 30.00	(15) 30.00	(14) 28.00	(21) 42.00	42.00	(16) 32.00	(24) 48.00	48.00
Storehousemen (2)	4.00	4.00	4.00	(2) 4.00	4.00	4.00	(2) 4.00	4.00	4.00	(4) 8.00	...	8.00	(4) 8.00	...	8.00
Other labor	...	...	...	(2) 4.00	(1) 2.00	2.00	(3) 6.00	(1) 2.00	2.00	(3) 6.00	(1) 2.00	2.00	(4) 8.00	(2) 4.00	4.00
Fuel, coal @ $3.50 per ton, oil @ 3½c. per gal., current @ 1c. per kw.-hr.	38.50	60.00	15.00	77.00	120.00	30.00	115.50	180.00	45.00	154.00	240.00	60.00	192.50	300.00	75.00
Ammonia, oil, waste, etc.	10.00	10.00	10.003	18.0	18.00	18.00	25.00	25.00	25.00	31.00	31.00	31.00	36.00	36.00	36.00
Net operating expense per day	$78.00	$98.50	$54.50	$138.50	$182.00	$93.00	$198.00	$262.50	$128.50	$257.00	$346.00	$167.00	$310.50	$422.00	$198.00
Total Cost of Operation per Year on Basis of Operating Full Capacity 4 Months, one-half capacity 4 months and One-quarter capacity 4 Months, equivalent to full operation for 216 days (60 per cent. load factor).															
Operating cost of equivalent of 216 days of full operation	$16,848	$21,276	$11,772	$28,670	$39,312	$20,088	$42,768	$56,700	$27,756	$55,512	$74,736	$36,072	$67,068	$91,152	$42,768
All labor expense for balance of year	4,248	4,104	4,248	6,264	6,336	6,192	8,280	8,280	8,424	10,368	10,800	10,944	11,808	12,384	12,528
Five per cent. depreciation on cost of mechanical equipment	3,100	2,600	3,500	5,950	4,950	6,750	8,550	7,050	9,750	10,900	8,900	12,500	13,000	10,500	15,000
Three per cent. depreciation on cost of building	1,125	1,050	1,050	1,950	1,800	1,800	2,850	2,640	2,640	3,600	3,330	3,330	4,500	4,200	4,200
Five per cent. on total investment for repairs, taxes, water and incidentals	4,975	4,350	5,250	9,200	7,950	9,750	13,300	11,450	14,150	16,900	14,450	18,050	20,500	17,500	22,000
Total annual expense	$30,296	$33,380	$25,820	$52,034	$60,348	$44,580	$75,740	$86,120	$62,720	$97,280	$112,216	$80,996	$116,876	$135,736	$96,496
Number tons ice produced annually	21,600	21,600	21,600	43,200	43,200	43,200	64,800	64,800	64,800	86,400	86,400	86,400	108,000	108,000	108,000
Total cost per ton of ice per annum	$1.40	$1.55	$1.19	$1.21	$1.40	$1.03	$1.17	$1.33	$0.97	$1.13	$1.30	$0.94	$1.08	$1.26	$0.90

A 1-c. rate per kw.-hr. for electric current is used because any higher price could not be considered. Even this figure does not compare favorably with either the oil-engine drive or steam plant. The claim is often made that the power consumption in such plants is less than 50 kw.-hr. per ton of ice; but the average electric-driven plant will be found to use nearly 60. As all the other figures in the table are made conservatively to represent everyday conditions, 60 kw.-hr. per ton of ice is quite appropriate.

The yearly load factor of 60 per cent. is equivalent to 216 days of full operation. This would mean about four months of full operation, four months at half capacity and four months at one-quarter capacity. In large plants in cities of considerable size these conditions usually exist.

Standard Wrought Pipe Bends

The accompanying table and illustrations of standard bends, taken from the National Tube Co.'s "book of standards," give the advisable radius and the least radius to which pipe of ordinary thickness may be bent. The radii



REFERENCE LETTERS TO DESIGNATE MEASUREMENTS OF BENT PIPES

given are as short as should be used to secure good results, but if they be reduced the thickness of the pipe must be increased.

Bends 12 in. and smaller to regular dimensions to be made of full-weight pipe; bends 14, 15 and 16 in. outside diameter to be not less than $\frac{3}{8}$ in. thick; bends 18 in. outside diameter and larger to be $\frac{7}{16}$ to $\frac{1}{2}$ in. thick.

For offset bends make a straight length between the bends in preference to the direct reverse bend. This is of advantage to the pipe bender.

With welded flanges there must be a short straight length of pipe between the bend and the flange. On sizes under 4 in. this straight length should equal one and a half diameters and on sizes over 4 in. one to two diameters of the pipe.

TABLE OF RADII FOR WROUGHT PIPE BENDS

Pipe Size In.	Advisable Radius R In.	Minimum Radius R In.	Pipe Size In.	Advisable Radius R In.	Minimum Radius R In.
2½	15	10	10	60	40
3	18	12	11	66	44
3½	21	14	12	72	48
4	24	16	13	84	60
4½	27	18	14	90	68
5	30	20	15	100	76
6	36	24	18 O. D.	125	90
7	42	28	20 O. D.	150	120
8	48	32	22 O. D.	165	132
9	54	36	24 O. D.	180	144

Erecting 3000-Hp. Barometric Jet Condenser

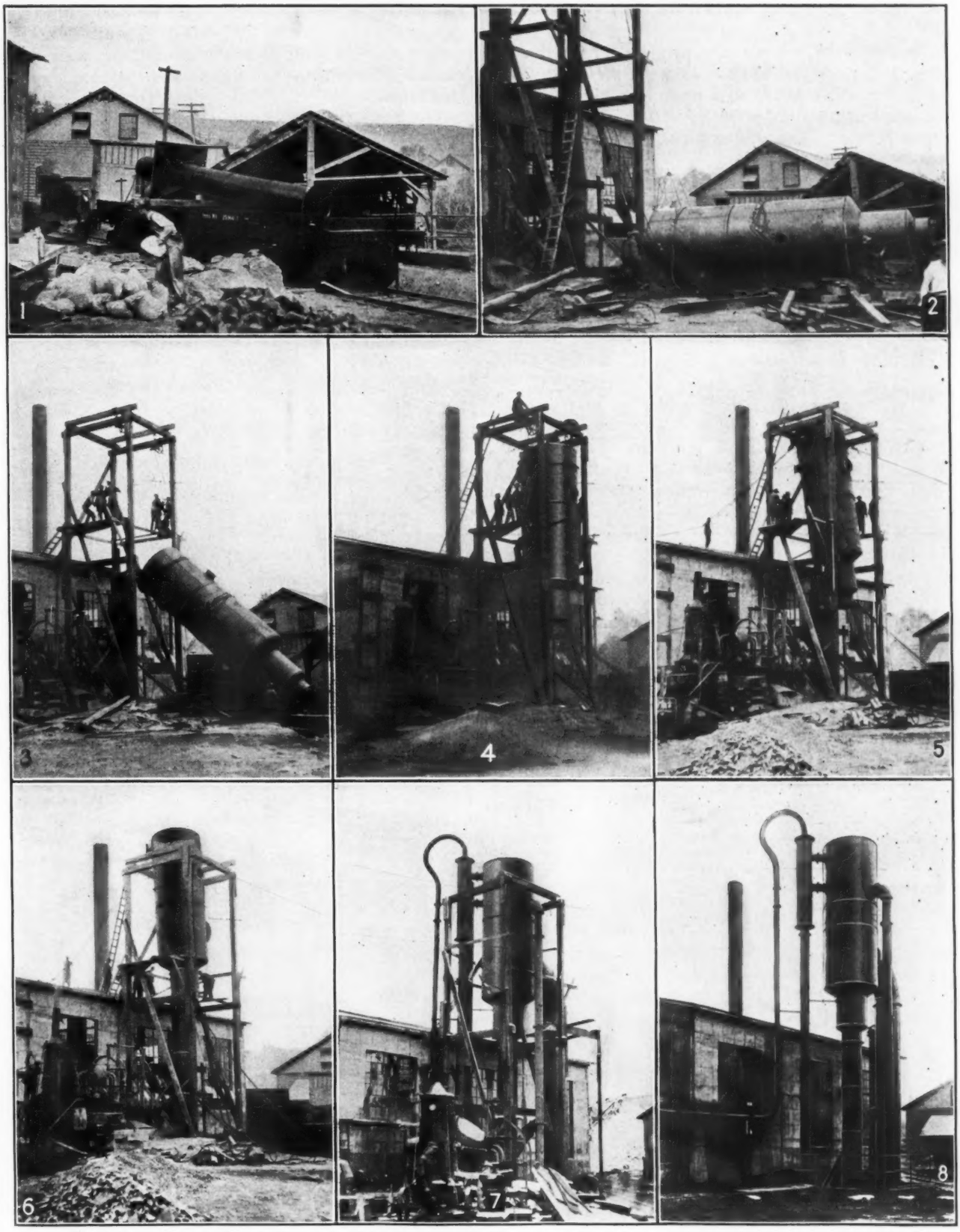
By Charles A. Hirschberg

The accompanying illustrations portray by successive stages the methods employed in the erection of a large Beyer-type barometric condenser (Cresson-Morris Co., Philadelphia, Penn.), with the ordinary apparatus available in most power plants—chain blocks and scaffolding. The design of the condenser itself embodies certain features which are of interest to the engineer. It was installed at the plant of the Whitehall Cement Mfg. Co., Cementon, Penn., to handle the exhaust from one new and two old installations of cross compound engines, each driving a 1000-kw. generator. The principal dimensions of the equipment are as follows:

Total weight	24,000 lb.
Weight of heaviest piece (condenser head)	16,000 lb.
Diameter of condenser head	84 in.
Height of condenser exclusive of hotwell	53 ft.
Length of head	24 ft.
Diameter of steam nozzle	42 in.
Diameter of water nozzle	16 in.
Capacity of condenser	3,000 hp.

This condenser replaced two of the parallel-flow type on a guaranteed cooling-water consumption basis. The water consumption of the new apparatus operating in conjunction with the three engine units was not to exceed that formerly required by the displaced condensers operating with but two units. It is significant in its bearing on the cooling-water consumption guarantee that the centrifugal pump formerly employed is now used to supply the new installation, and reports show that the condenser is maintaining continuously 28 in. of vacuum, which is somewhat better than that formerly obtained.

This condenser consists essentially of five parts: The hotwell, which is of concrete; the barometric leg pipe and the condenser head, which are of metal; and the secondary pipe, in two sections. The plant is on the Lehigh Valley Railroad, with a spur running into the grounds, Fig. 1, and as the power house is within a few feet of the track the condenser parts were skidded from the cars and hoisted into place with the tackle. A concrete mixer was placed adjacent to the point of erection, proper forms set for the hotwell and the concrete dumped from the mixer into these forms. After the concrete had hardened a scaffolding was erected and two ordinary chain hoists suspended thereon. The barometric leg pipe, shown in Fig. 1, straddles the



FIGS. 1 TO 8. SHOWING THE SUCCESSIVE STEPS IN THE ERECTION OF THE CONDENSER

hotwell and was erected first, it being secured in position by bolts embedded in the concrete.

Fig. 2 shows the next step, with the condenser head placed adjacent to the scaffolding preparatory to hoisting. Fig. 3 shows the condenser just prior to its entry inside the scaffolding, and Figs. 4 and 5 the successive stages in the progress of hoisting. The condenser head, in place ready for bolting to the barometric leg pipe, is shown in Fig. 6, and Fig. 7 shows the complete erection of the condenser and secondary piping just prior to the tearing down of the scaffolding. The various sections were riveted together by pneumatic riveters in the shop,

and bolted connections provided for their joining in the field.

The condenser is made of steel plate throughout, and all parts were subjected to a 50-lb. water-pressure test and all joints calked under that pressure. The total time consumed in installing was three 10-hr. days, nine men doing the work. The total expense for lumber, labor and rigging was $146.70.

Fig. 8 shows the plant as it appears today and shows the practically dry discharge from air-pump discharge pipe projecting through the roof at the left. The condenser is of the counter-current design, the steam to be condensed entering at the bottom and the cooling water from above.

The work of erection was under the supervision of Arnold Hochstrasser, superintendent of the Whitehall Cement Manufacturing Co., and indebtedness is acknowledged for information and photographs.

Tom Hunter, Hoisting Engineer

By Warren O. Rogers

SYNOPSIS—I meet Hunter in Alabama and together we inspect the works and mines of the Woodward Iron Co. The power plant consists of reciprocating engines and mixed-pressure turbines. Condensing water is cooled by means of spray nozzles and a pond. At the mines electric hoists are employed, using liquid rheostats for controlling the speed of the motor driving the hoisting drums.

It was some weeks before I met Hunter again after leaving Johnstown, Penn., he going West and I East. In fact, the summer had passed, and while snow and frost

FIG. 1. COOLING POND AND SPRAY NOZZLES

were the order of the day, I had occasion to go South, Birmingham, Ala., being my destination. As the hotel bus rattled up the street from the railroad station, I failed to recognize any of the occupants in the darkness, and would have entered the hotel with but a few casual remarks had not one of the party accidentally knocked against me. Turning, I was confronted by my friend, Hunter, who began a profuse apology for his awkwardness, but ended by nearly knocking the breath out of me a second time with a full-fledged thump on the back.

"Mines," said Hunter, in reply to my inquiry as to his presence, "always mines. I expect to end up underground one of these days the same as will most of us."

The evening was passed in mutual enjoyment of each other's companionship, and before separating for the night, we had arranged to visit some of the iron mines a few miles from the city at a later date when we would both be at liberty for a few days.

One of the first mines to which we went was that of the Woodward Iron Co., taking in the power plant at the iron furnaces first. Hunter, as usual, gave a discourse on operating conditions as we rode to the plant.

"You will find," said he, "a pretty nice steam plant for a blast-furnace proposition, for these people are wide-awake. We won't have any trouble getting permission to go wherever we want to." And we didn't.

"The trouble," said Hunter, "with many operators has been that they were indifferent to the fact that the cost of coke making, and of smelting iron, steel and other products is largely influenced by the expense of mining coal, and that the generation and distribution of power play an important part. They are now looking at the matter from a different point of view than formerly.

"We have had several talks on electrical-power transmission, and I want to emphasize the fact that for a system of any extent the transmission of power can be effected in the form of electricity over suitable transmission lines with far less loss than through steam pipes, by compressed air or in any mechanical form."

"Yes," I replied, "You have said something of the sort."

"The trouble has been, where single mines have been operated by individual companies, that the element of operating expense, on account of its being relatively small, has been almost lost sight of. But where a number of mines are grouped under a single management, the economic generation of power is now being considered, and the same principles are now being applied that are being used by large consumers of power for purposes other than that of mining.

"In the principal coal-mining districts the plan has been adopted of generating all or nearly all of the power used on the property in a single power plant from which it is distributed to the various workings; the Woodward company is one which is doing this."

At this point in Hunter's conversation we reached the office of the company, and were given the run of the works and mines, so to speak. Our reception was so cordial and our request to visit the works so readily granted that I, at least, almost felt that we were doing a favor in making the visit; quite different from the reception accorded us at some other works later on.

As we walked toward the furnaces along the trolley line, Hunter reopened his discussion by saying: "Here we will find the electrical energy generated in a power plant, where one set of engineers and firemen take the place of several sets in smaller plants, which reduces the labor cost as well as numerous other expenses in proportion. The coal and ashes can be handled more cheaply and the units may be operated condensing. Furthermore, repairs and maintenance are required for a few large units rather than for many small ones."

When we entered the power plant, we found a combination of reciprocating engines and turbine units. (Fig. 2 shows two views of the plant from opposite ends.) These consisted of one 22&66x28-in. cross-compound engine driving a 3300-volt generator; three 18&42x30-in. cross-compound engines driving direct-connected units; two mixed-pressure turbines, each of 1,000-kw. capacity, and a 36-in. main. The smaller pipe supplies water to 54 nozzles arranged in groups of three nozzles each. The 36-in. line supplies two branch pipes, each feeding 54 nozzles. The cooling pond is 150 ft. square. The injection water is taken from a point near the end of the engine room through a concrete intake, from which the turbine-driven centrifugal pumps take the injection water.

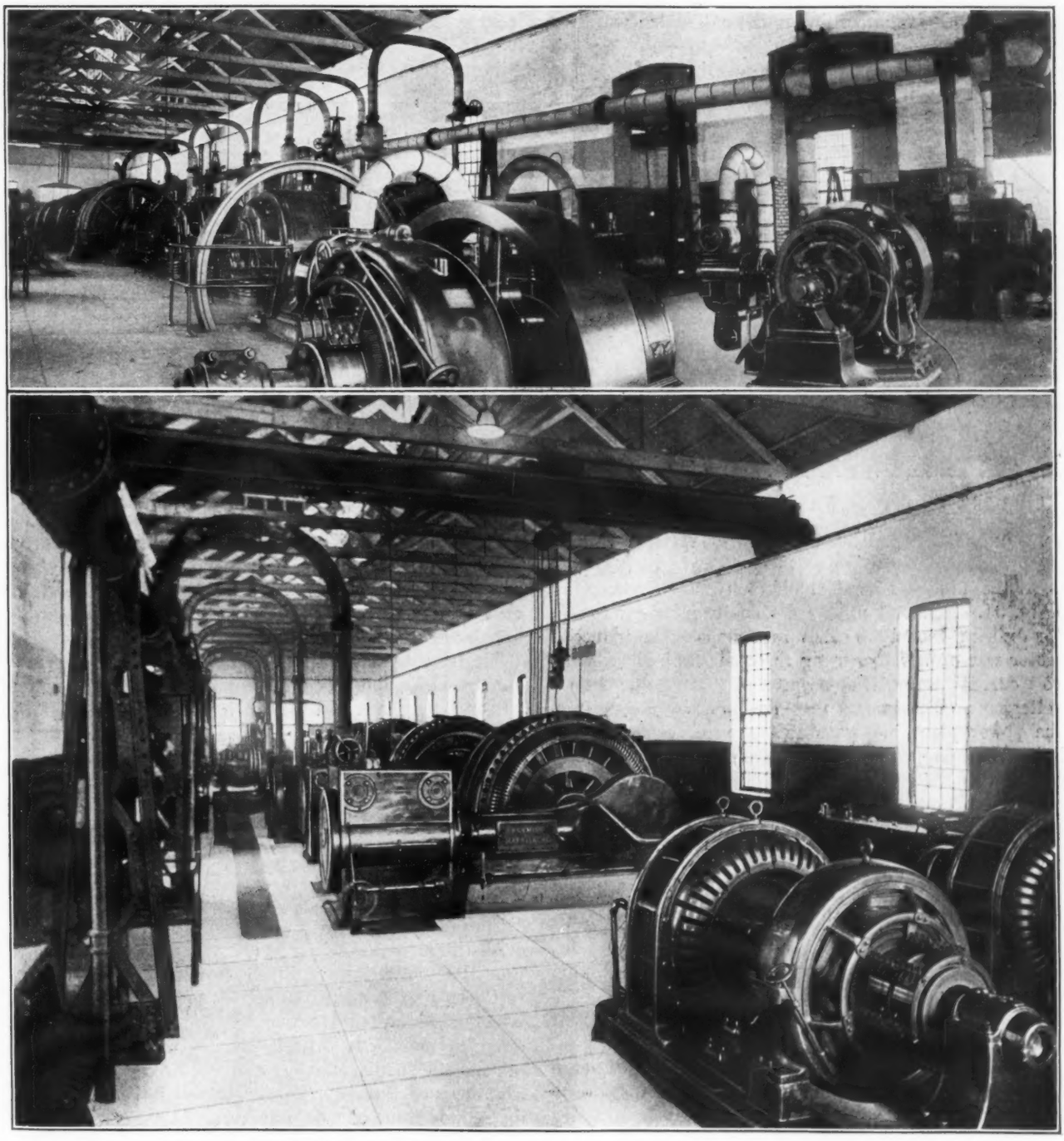


FIG. 2. TWO VIEWS OF THE POWER PLANT OF THE WOODWARD IRON CO., WOODWARD, ALA.

besides a turbine and two engine-driven and one motor-driven 125-volt exciter units; turbine-driven centrifugal pumps for injection water; air pumps; and two 200-kw. motor-generator sets. The barometric condensers are outside of the building, and the injection water is obtained from a cooling pond (Fig. 1). Waters from the condensers is pumped to the 162 spray nozzles through a 24-

The output of this plant is used about the works for motor circuits and for electric lighting. It is also transmitted to the iron mines of the company for hoisting and mine work.

"You see," said Hunter, as we drank a bottle of Coca Cola, or "dope," as the engineer called it, "they have an uptodate plant here, with all the refinement of a central

station. I observed from the thermometer readings that the hotwell water is 71 deg. and that it is cooled to 66 deg. in the spray-nozzle pond, a change in temperature of about 5 deg. In the summer months the temperature of the pond water would doubtless be around 80 deg."

Upon leaving the plant for the mines, we boarded an ore-train locomotive with some misgivings, for we had been told that two accidents had happened and that the third one was due, according to the old-established belief. However, nothing happened on the run, except that the locomotive was nearly stalled on the climb up the mountain, although it had but a train of 12 empty cars, so steep was the grade.

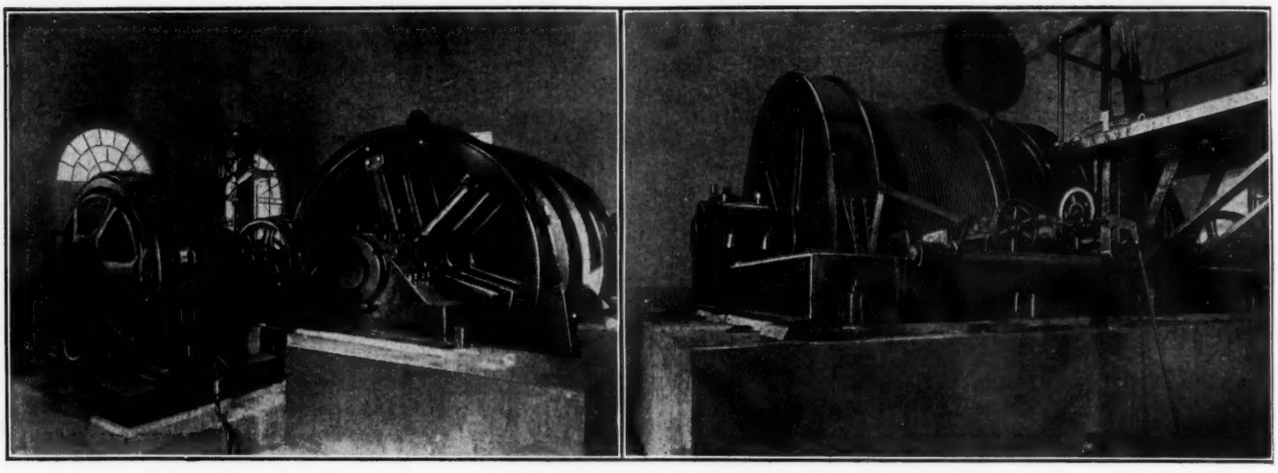


FIG. 3. TWO VIEWS OF ONE OF THE ELECTRICALLY OPERATED HOISTS

At the mines we found the latest type of electric hoist (Fig. 3). At No. 1 mine a double-drum hoist was used for drawing loaded ore cars up the slope. The induction motor was of 700 hp., using three-phase 25-cycle 3,300-volt current, and ran at a speed of 300 r.p.m. As the voltage was the same as that generated by the units at the power plant, no transformers were required. The hoist was equipped with a secondary resistance and control liquid rheostat, which itself does not handle the primary current, but contactors are used for closing and opening the primary circuit.

"Those rheostats work all right," said Hunter. "One of the problems was to get a sufficiently high ratio of maximum to minimum resistance, so that with the same adjustment of density of liquid, a sufficiently slow crawling speed could be obtained for taking up slack rope, etc., without resulting in seriously decreasing the maximum full running speed, when hoisting a heavy load."

"How is it made?" I asked, this being the first rheostat of the kind I had seen.

"It is made with separate high- and low-resistance sections. The low-resistance section is automatically switched in and out of circuit as required by an auxiliary contactor, and the resistance of each section is changed by varying the height of the liquid. The area of immersion of the stationary electrodes, and of course the resistance, is varied by raising or lowering the height of the liquid by a small centrifugal pump, which pumps the liquid into the electrode chamber and overflows a movable weir into the cooling chamber.

"With the weir in its lowest position, the electrodes are but slightly submerged and the resistance is high. As the control lever is moved over toward the running position in either direction, it raises the weir, which causes the electrode chamber to fill gradually to a level corresponding to the position of the weir and submerge the electrodes. This decreases the resistance and allows the motor to run faster.

"If the control lever is moved to an intermediate position the weir is raised part way, and the liquid may be raised to an intermediate level, and in this way a lot of partial-speed running points can be obtained."

"That hoist should gladden the man who operates it, especially if he has been used to the steam hoist with its noise and levers," I remarked, as we tramped down the mountain side toward the nearest point where a street car could be caught to take us back to town. "No steam or splashing oil and everything of the latest design of apparatus and a mighty neat layout."

"It is that," rejoined Hunter, "and what is more, if you travel around the mines for the next few years you will find that they will have displaced the steam hoist in many instances."

Then the trolley arrived and we were back to the city just as the first stars began to twinkle in the Southern sky.

*

Fairbanks, Morse & Co. Semi-Diesel Oil Engine

A semi-Diesel oil engine operating on the two-stroke cycle and designed to consume any grade of crude oil or distillate is now being made by Fairbanks, Morse & Co. Horizontal engines, Fig. 1, in sizes up to 25-hp. and verticals, Fig. 2, up to 100-hp. are now being made, and larger sizes are in course of preparation. On oil ranging from 26 to 37 deg. Baumé, the fuel consumption on the smaller engines does not exceed 0.1 gal. per b.hp.-hr., and the regulation is claimed to be well within the requirements of electric parallel operation.

As usual with this type of engine, there are no valves, the piston itself covering and uncovering the inlet and exhaust ports. Crank-case compression not in excess of 2 lb. is used for scavenging and recharging. Compression in the cylinder is carried to about 175 lb. The combustion chamber is maintained at a comparatively low temperature, since it is water-jacketed the same as the cylinder. It is entirely separate from the cylinder and is made with heavy walls, so that there is the same factor of safety in its operation as there is in the cylinder.

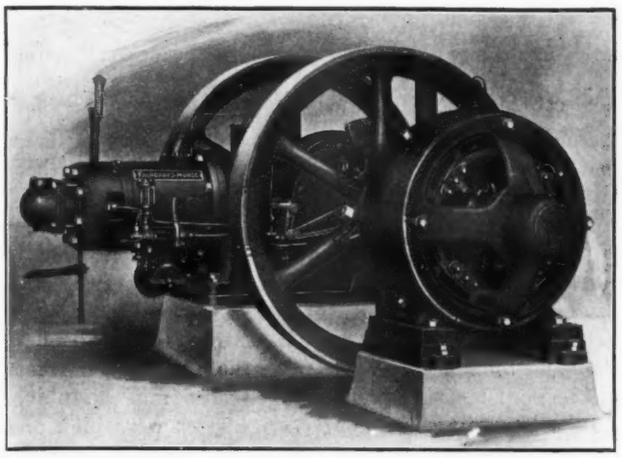


FIG. 1. HORIZONTAL TYPE

Special arrangements have been made to facilitate starting. When starting the engine cold, a kerosene torch is placed on the bracket below the combustion chamber until an auxiliary starting tube projecting through the wall of the chamber is heated sufficiently to ignite the charge. Since the heating is restricted to this tube, it is not necessary to bring the walls of the combustion chamber up to the ignition temperature, and much time is saved.

The fuel-injection pump is shown at the side of the engine in Fig. 1. It is driven through a rocker-shaft end and eccentric on the main shaft. The position of the eccentric, and therefore the length of the stroke of the pump, is controlled by an inertia shaft governor. The amount of oil consumed by the engine is automatically varied to meet the requirements of the load. To withstand the high pressure against which the injection pump must operate, it is constructed of a hardened and ground steel plunger with steel valves on bronze seats.

An immediate supply of oil to the pump is carried in an auxiliary reservoir mounted just above it, as shown in Fig. 1. This reservoir is supplied from the main storage tank by a small plunger pump driven by an arm on the rocker shaft. This same arm drives a force-feed

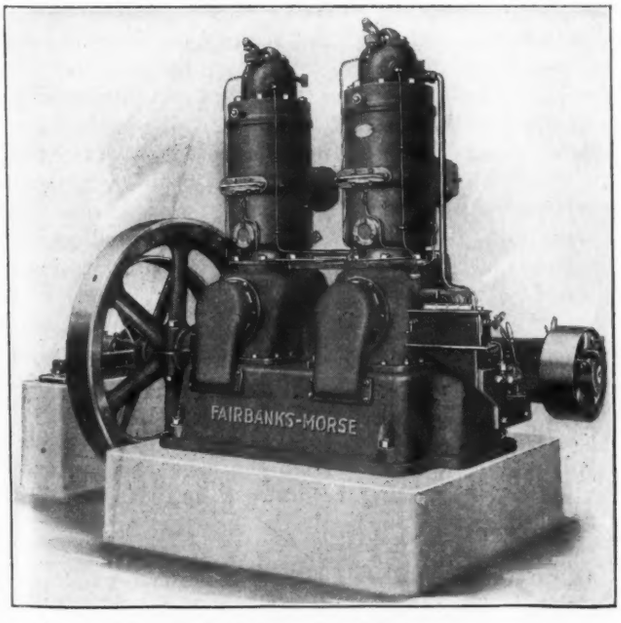


FIG. 2. VERTICAL TYPE

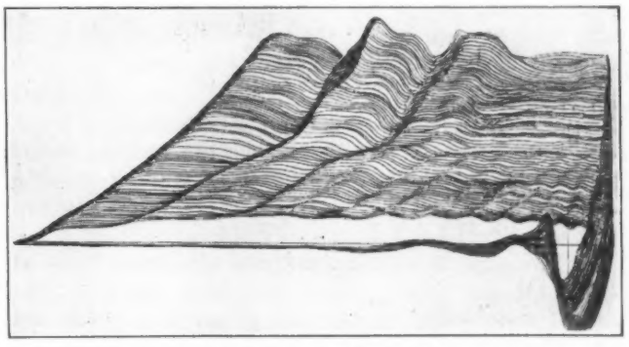
pump lubricating the cylinder. The reservoir is provided with an overflow pipe, which returns any excess oil to the suction side of the pump. Through the glass walls of the reservoir, any interruption of feed may be detected. A hand lever for starting the engine is also provided. By means of this lever sufficient oil may be injected for a preliminary charge, and at the same time the pump plunger may be held back until the engine is under way so that the danger of flooding the cylinder is obviated.

An unusual feature for engines of this type is that the main bearings are ring-oiled, the large oil reservoirs reducing the attention usually required. By means of a special air-seal ring around the bearings in the crank case, the compression of the entering charge of air is prevented from interfering with the lubrication. The cylinder, crankpin and piston pin are oiled by the force-feed pump previously mentioned.

Indicator Diagrams from Blowing Cylinder

By Charles E. Sampson

The indicator diagram shown is from one end of a 84x60-in. blowing cylinder of a 42x60-in. twin tandem blast-furnace gas-engine unit. The tracing was started upon receiving from the furnace the check signal, which called for the engine to be slowed down during the cast-



DIFFERENT PRESSURES ON THE SAME DIAGRAM

ing period, and shows the reduction of pressures due to this change in speed and the opening of the "snort valve" at the furnace.

The upper line shows the normal blast pressure at 40 r.p.m., while the lowest lines show the condition when the engine was running at 28 r.p.m. with about 2 lb. per sq.in. blast pressure.

The air inlet is controlled by the Slick blowing tub valves, while the outlet is through steel-plate valves.

Production of Coal in 1914

The production of coal in the United States in 1914 was exceeded by that in only two previous years—1912 and 1913. In 1914 the total production of anthracite and bituminous coal amounted to 513,525,477 short tons, valued at $681,490,643, according to C. E. Lesher, of the United States Geological Survey. In 1913, the year of greatest production, the total was 569,960,219 short tons.

In 1914 the value of both bituminous and anthracite coal decreased slightly more than the tonnage, but the decrease in anthracite, the more valuable output, was slight. The production of anthracite in Pennsylvania decreased from 91,524,922 short tons, valued at $195,181,127, in 1913, to 90,821,507 tons, valued at $188,181,399, in 1914. The total production of bituminous coal and lignite decreased from 478,435,297 short tons in 1913, valued at $565,234,925, to 422,703,970 tons in 1914, valued at $493,309,244.

An Inexpensive but Accurate Gage Tester

By F. W. Salmon

Engineers realize the necessity of frequently testing their pressure gages to make sure that they are correct. In many plants the boilers are insured and the insurance company's inspector tests the pressure gages. In outlying districts where this is not the custom, gages sometimes become injured or there is a doubt about their accuracy; hence, in some plants testing machines are found, but good instruments are quite expensive.

The illustration shows the details of a simple gage tester that can be rigged up in almost any machine shop or mine repair shop, with such scales as may be found in the plant or store.

Let us take a case from actual practice. We visited a mine where the boilers are not insured. The gages had been in use about ten years and the owners thought they were all right, but had no test gage or testing set. We found a platform scale reading up to about two thousand pounds, a lathe in one corner of the engine room, some tubing about ⅛-in. diameter that had been used for gasoline lighting, an 8x8x1-in. cast-iron plate and a $3\frac{15}{16}$-in. shafting gage of the ring type. With these and the smaller parts shown, we were able to rig up the tester illustrated, in a couple of hours.

As the area of a circle $3\frac{15}{16}$ in. in diameter is 12.177 sq.in. and we wish to test the gage at 100 lb. per sq.in., we must balance the scales and then load them with weights to correspond to 1,217.7 lb. When the bolts are screwed down till the pressure under the $3\frac{15}{16}$-in. plunger just causes the scales to balance, the pressure gage should read 100 lb. per square inch; and so on with other pressures. For 150 lb. set the scales at $12.177 \times 150 = 1903.5$ lb.

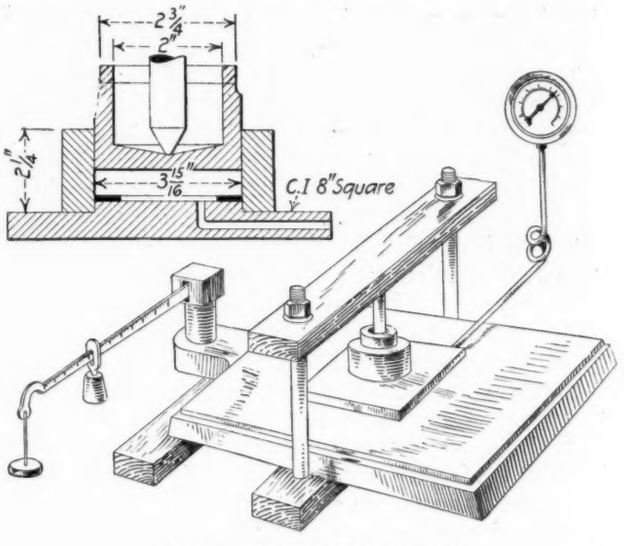
The pressure gage can generally be set so near the level of the plunger that no correction is necessary for the head of water or oil in the tubing, but if it is set very much above the plunger 0.434 lb. per square inch should be added for each foot of water, and for oil in proportion to its specific gravity. Thus, if the pressure gage is 5 ft. above the plunger and gasoline is used having a specific gravity of 0.83, the real pressure at the gage would be 0.434×5 ft. $\times 0.83 = 1.8$ lb. (about) per square inch less than at the plunger.

Shafting-ring gages of suitable size may be found almost anywhere, and as they are carefully made we can depend upon their accuracy. In most cases they can be made oil-tight at the bottom in the manner shown, or we can pour a little hot paraffin around the inner joint under the leather washer. In the latter case care should be taken not to get wax on the sides of the ring gage, as this will obstruct the free action of the plunger. We have found little difficulty in getting these plungers made in almost any out-of-the-way place by simply drilling out the center before turning up, being careful to have the small square oil grooves on the periphery.

We prefer as large a ring gage for a cylinder as the scales will allow, as then we get a larger reading on the scales, less error from friction and more accurate results all around. Besides, the larger the plunger the less the chance for oil leakage.

As to the precision of this arrangement we may say that if made and operated with ordinary care, it is more accurate than is usually required for gage testing, for such scales can generally be read easily to the nearest pound, which would be equivalent to $\frac{1}{12.177}$ lb. per square inch on the pressure gage; and as to friction of the plunger in the shafting-ring gage, as the push rod *F* is pointed at both ends and bears against metal (and can be case-hardened and polished if desired) the plunger can be easily turned by means of notches and a small bar or wrench at the moment the scales balance at the set load, thus practically eliminating friction there. And if a reasonable length of coiled tubing is used between the pressure gage and base plate and the scales balanced with these in position, there will be no perceptible effect on the scales from the tubing.

In a city where the hourly wage rates were high and everything had to be paid for except the ring gage the cost of one of these outfits was: Cast-iron base (pattern,



GAGE TESTING RIG IN USE

25c.; casting, 75c.; machining, $1.50), $2.50; plunger finished, $1; push rod, 50c.; copper tubing, 25c.; two ¾x15-in. bolts with nuts, 50c.; total, $4.75.

In many cases the same base plate can be used for several plungers and ring-shaft gages, but care should be taken that the leather does not obstruct the pressure hole, and that the plunger is so high above the base that the scale load is fully carried on the oil, and not mechanically on any part of the base.

Better results will often be obtained with a device like this than with a highly finished ready-made instrument. It is large and substantial; the men who use it have helped to make it and fully understand it and use it intelligently; it is always at hand, and will be more frequently used and so result in greater good.

We have known of gages being injured by attempting to remove the hand to reset it, so we believe it is better not to attempt this but to make notes of the true pressures, and against these the gage readings, and post near the gage. Thus for intermediate pressures the true pressure may be readily estimated from the gage reading, or a curve of corrections may be drawn through these points and posted.

An Erratic Synchronizer was responsible for the summoning of a trouble man. Upon reaching the station he noted a burning odor, which he traced to one of the synchronizing plugs that made such poor contact that it smoked.

Editorials

Precedents and Power Problems

Whenever a central station obtains a contract for electrical service on the premises of a big industrial customer, it is only natural that the achievement should be worked for all it is worth in the publicity department of the electric company and used as a strong "talking point" in endeavoring to bring other large power users into line as consumers of central-station service. No one need criticize this sort of exuberance, but it is time that the operating engineer, superintendent of motive power and master mechanic realize again the absolute inconclusiveness of any such contract as a precedent for other motor, water or steam-driven installations. If there is any place where fashion should be made to walk the plank, it is where one comes to conclusions regarding the economy of a given type of power service for an establishment on the basis of what seemed to be the best course for another fellow. If the engineer in a mercantile or industrial organization cannot make his employers realize this, it is time for him to quit the job.

A vast deal of talk is heard these days about tendencies among large users toward purchasing service of various kinds on the centralized basis. To come down to a concrete example, suppose the Smith Electric Co. after long and exhaustive work lands the Jones Manufacturing Co. as a customer. Pretty soon President Williams of the equally large Williams & Johnson concern plays eighteen holes of golf some fine autumn afternoon with Manager Hudson of the central station, and as the pair seat themselves on the country-club piazza for a few moments before starting homeward, Hudson sets forth the progressiveness of the Jones company's policy, and taking as his text the point that what is good for one big concern must surely be just the thing for another, does his best to convince Williams that the only thing left for him to do is to come over to central-station service, contending that the thoroughness of the Jones investigation and the standing of that concern have simply settled the case for plants of that particular grade. Now, Williams is no engineer, and he entertains a profound respect for the Jones company, and this sort of an argument, presented in the glow of enthusiasm perfectly legitimate on the part of the central-station manager, sets him thinking.

Before long Williams & Johnson's engineer hears that the president is leaning toward the installation of central-station service, and perhaps the subject is brought up casually by the superintendent as he makes his rounds of the property or calls the engineer into the office for routine conference. Now the engineer of such a plant must know that the single object of his work is to produce safely and with one-hundred per cent. reliability the lowest-cost power possible with the layout of plant equipment under his command, and it is entirely proper for him to urge upon his superior that an adequate investigation be made before a change in power policy is effected merely on the strength of what some other big concern is doing. If that investigation shows that service should be purchased, well and good; but let every man in the organization having to do with power production urge with all the vigor consistent with due courtesy that every power problem must be solved rightly on its own merits; that incidental lessons may indeed be drawn from the decisions of other concerns, but that nothing short of a thorough analysis of local costs, loads, condition of equipment, possibilities of future expansion in plant or mill and numerous other factors will enable a sound engineering conclusion to be reached. In the face of such advice, respectfully but confidently proffered and with the best interests of the employer at heart, the futility of settling important engineering questions on the basis of a wholesale admiration for the acts of some other concern, no matter how famous, will become apparent to any plant manager worthy to hold his position.

Safety Valves vs. Water Column

On another page appears a letter discussing and asking further discussion of the relative importance of the safety valve and water column in the destiny of the boiler plant. There seems to be no basis for comparison and no such a thing as relative importance in this case. Each has a separate and important function to perform, and should either fail to operate properly the safety of the boiler is endangered. Boiler explosions are invariably the result of over-pressure—pressure greater than the boiler plates or parts can withstand—therefore if the safety valve fails to act before the accumulating pressure reaches the limit of the strength of the weakest part of the boiler, the boiler fails and the result is more or less serious as the case may be.

On the other hand, if the water gage or column fails to indicate the true water level and the boiler is subjected to such injuriously high temperature that its structure is weakened, then the safe working pressure and the pressure at which the boiler will actually explode are materially lower than before. Therefore an explosion may occur from what is actually over-pressure, even with the safety valve in perfect working order and acting at the pressure for which it was set.

It is altogether likely that many of the "mysterious" explosions are the result of the repeated abuse of the boiler by subjecting it to the overheating effect of low water—not necessarily at the time of the accident, but at any time in the life of the boiler—or even overheating and other mistreatment in the process of the manufacture of the plates.

It is indeed fortunate that boilers do not explode every time the safety valve gets out of order or the water gets low, nor is the engine always wrecked by high water; nevertheless, neither safety valve nor water column should be neglected nor, if both are in the best possible condition, should vigilance be relaxed. The conclusion therefore

is that neither attachment is entitled greater consideration than the other, since both must be given sufficient attention and kept in the best working condition in order to be trustworthy.

Another point referred to in the same letter is the apparent difference in the use of the term test or tested, with the inference that blowing down the water column is for the sole purpose of ascertaining whether the water-level indication is the same following the "blow" as before and how promptly it is established. In reality the primary object is to clear and keep clear the connecting passages to the boiler, and the other feature is an indication of whether they are clear or not. Similarly, blowing down a boiler is not so much to ascertain whether the blowoff is clear as it is to clear it and the boiler of all the sediment and scale possible. If in either case there is indication of stoppage, action is taken toward removing it.

It is believed that the use of the term test in the Hartford rules applies to a test of the column for height in relation to the boiler and other conditions, when the boiler is out of service, similar to testing the steam gage, which is referred to in the same connection. The writer of the letter is, however, right in urging that the water column be given a frequent blowdown; daily, or several times during the day if the water is bad.

The Lure of Perpetual Motion

A wholesome lesson may be learned by the young, and perhaps by those not so young, from the repeated failures of seekers after "something for nothing" mechanically, or perpetual-motion enthusiasts—not to say cranks. A daily news item from Minneapolis tells of death ending such a fruitless quest after it had extended over a period of 70 years. "It almost worked!" "Ah, if I could only just get the one little missing link!" tells the life story in a few words.

In an Indianapolis daily is shown a machine called the "hydrodynamo," intended to be operated by steel floats hoisted by water to rotate a large wheel in their descent, "creating power." The machine is described as being about two stories high, weighing hundreds of tons, and is said to have cost the Indiana Power Co. about $40,000. The fallacy of the idea was exposed in *Power* of Oct. 18, 1910, and it was abandoned after the stockholders failed to continue to provide funds. It is understood that another attempt is being made to float it, but it is such a palpable mechanical absurdity that anybody who takes stock in it deserves to lose his money.

The United States Patent Office has long since established the "show me" rule in all such cases—a working model to accompany the application for a patent. Modesty or other considerations sometimes deter the "discoverer" from claiming perpetual motion, but simply a means of "multiplying power."

Those engaged in such enterprises are easily divided into two classes: First, those who are sincere, although they are either ignorant of physical laws or do not believe the commonly recognized laws correct—thinking they have discovered a way to "beat the game." This class are usually secretive, desiring to safeguard the secret and reap glory and wealth untold when final success is accomplished. The other class, while delightfully frank and communicative, utterly fail to convey to others the great mystery of the discovery because of the inadequacy of human language, and proceed to concoct new terms to meet the requirement—of separating the credulous from more or less good money in return for "shares," or "stock." One uses his own funds and hopes to develop an operative machine, the other uses the funds of others. One represents a loss to himself and dependents, if any, and the loss of a productive unit to the community, while the other not only does not produce, but dissipates that which others have produced and perhaps can ill afford to lose—as lose they must.

Hydro-Electric "Uneconomics"

According to an article in the Columbus (Ohio) *Dispatch,* there is a project on foot to "harness" the Colorado River in the Grand Cañon by a series of six hydro-electric plants with a total capacity of 400,000 horsepower. Moreover, it is said that construction work will be started within eighteen months. The plans contemplate using electricity for the operation of railroads, mines and industrial plants, and for lighting towns and cities in a big scope of territory.

The Grand Cañon offers certain advantages for such a proposition. Ample storage space can be procured, its volume being limited only by the distance from the bed of the river to the rim of the cañon. This is an important consideration because the flow of the Colorado River fluctuates between wide limits. The transportation of nonbreakable building material could be easily accomplished, provided sites were chosen where the sides of the cañon had an uninterrupted slope from its rim. Under present conditions the disposal of such a large amount of power would be somewhat difficult, but it is possible that the mere announcement of the undertaking will be sufficient to transform the sparsely settled near-by states into hives of industry and the present steam- into an electrified-railroad system.

At the Kineo convention of the New England Section of the National Electric Light Association the question "Why Central Stations do not Get all the Big Power Business," was discussed. H. B. Emerson, of the Arlington Mills, Lawrence, Mass., showed that an isolated plant generating ten million kilowatt-hours a year could save nearly twenty thousand dollars annually by making the current over buying it at one cent per unit. In the discussion the point was made, however, that a modern central station would meet this rate without difficulty on such a large output—and with the same pen sign a sworn statement to the public service commission that the cost to it is three or four cents.

The editor of *Steam* is just a little mite exigent. "An evaporative efficiency of seventy per cent.," he says, "is by no means satisfactory. We should get from ninety to ninety-eight per cent."

Don't overlook the fact that the boiler wall must be overhauled occasionally and put into good condition, as well as the interior of the boiler itself.

Some buy the kind of supplies they need and others buy the kind some smart salesman makes them think they need.

Correspondence

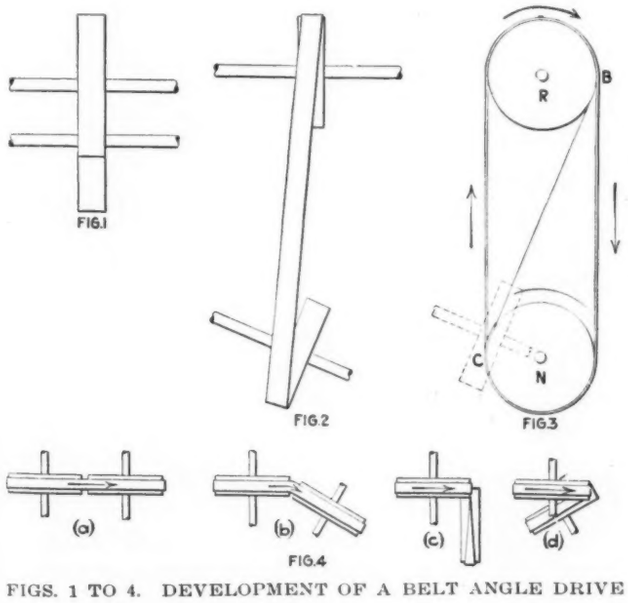
The Quarter-Turn Belt

By W. F. Schaphorst

The simplest rule to remember in arranging quarter-turn belts is, "As the belt leaves either pulley it must lie in the plane of the other pulley." The exact meaning of "the plane of a pulley," illustrated in Fig. 1, is a plane passing through the center of the pulley at right angles to the shaft.

This rule applies not only to quarter-turn belts, but to any angle from zero to 180 deg. and to any drive. To illustrate, in Fig. 2 the two pulleys are not in alignment. The shafts lie in the same plane, but are not parallel; hence as the belt leaves either pulley it does not lie in the plane of the other pulley and therefore will not run on the pulleys without being held there by guide pulleys or other means.

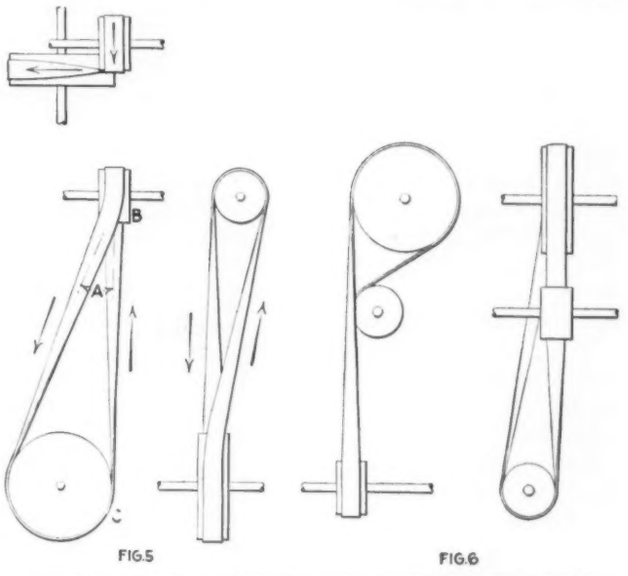
To set one pulley at any angle with the other, retaining a running condition at the same time, a diagram like Fig. 3 is useful. Pulleys R and N are drawn as a common open-belt drive, and then the diagonal line BC is drawn. Holding pulley R rigid, rotate pulley N about the axis BC to any position or angle, and with the belt running in the direction indicated the conditions of the foregoing rule will be fulfilled. That is, "as



FIGS. 1 TO 4. DEVELOPMENT OF A BELT ANGLE DRIVE

the belt leaves either pulley it will lie in the plane of the other pulley." By turning pulley N through 90 deg., as is usual with quarter-turn belts, it will occupy the position indicated by the dotted lines, and it is evident that the belt will not run off the pulleys. Fig. 4 shows the application of Fig. 3 more fully for a number of angles, where a is a common open-belt drive. At b pulley N is turned through 30 deg., at c we have the quarter-turn and at d a turn of over 150 deg., and the conditions of the rule are fulfilled in every case. The next step would be a common crossed-belt drive, so it is evident that the theory is very simple, but in practice we find that it is not as easy as it looks, principally because the theories are incomplete and do not consider the weight of the belt at all. Hence the pulleys must be adjusted by trial until the belt runs suitably.

Pulleys for drives of this kind should have plenty of crown, and they should be wider than the average



FIGS. 5 AND 6. QUARTER-TURN BELTS WITH AND WITHOUT IDLER

pulley on account of the leading-off angle A, Fig. 5. This angle is greater on pulley B than on pulley C of the same drive on account of the difference in their diameters, but when equal the angles will be equal. The pulley widths depend upon their diameters and the distance between shaft centers. The greater the distance between centers, the narrower may be the pulleys. In designing a drive it is best to lay it out on paper and see how great the leading-off angles will be and select a suitable width—and there can be no guesswork about it. Our best authorities state that no greater leading-off angle than 25 deg. should be used. This occurs when the distance between shaft centers is equal to twice the diameter of the largest pulley.

The leading-off angle should be made as small as possible so as to reduce the fiber stresses and prevent undue wear. Quarter-turn belts often wear rapidly because of grinding action at the point of leading off, and the greater the angle the greater this action will be. For this reason it is desirable not to use pulleys with leather coverings or belts with high coefficients of friction, so that the slip will take place with as little friction as possible.

A good "kink" in the operation of quarter-turn belts is to turn one end of the belt before lacing, through 180 deg., so that both sides of the belt will come in

contact with the pulleys and both edges will be stretched equally, and the wear will be uniform all over. Otherwise one edge and one side always "get the worst of it."

As for the selection of pulleys and belts, the smaller the pulleys the less will be the leading-off angle, but small pulleys are not so efficient. Large pulleys and a narrow belt and as great a distance between pulleys as possible make the best selection. The best belt speed for highest economy being from 4,000 to 4,500 ft. per min., the most economical combination of belt and pulleys may be easily determined by following the method employed for common open drives. The usual rule for single belts is, "Each inch in width, running 800 ft. per min., will transmit one horsepower." For two-ply belts use a speed of 500 instead of 800. Instead of using single-ply wide belts on quarter-turn drives, it is better to use thick narrow ones on account of the twisting stresses and the surface wear.

Fig. 6 shows a method sometimes employed to reduce the leading-off angle on the small pulley to zero by an idler, but an idler is always objectionable on the tight side of a belt because it absorbs some power. If an idler is used at all, it should be perfectly aligned, should not be too small and should be as nearly frictionless as possible. It has been demonstrated in open drives that idlers, properly designed and placed, absorb almost zero power, and with quarter-turn drives equally well-designed and placed the efficiency should be just as great.

It must be noted that not one of the quarter-turn drives shown here is reversible, because the belt when leaving the small pulley does not lie in the plane of the large one. But Fig. 4 could be made reversible by the use of another idler. Therefore a quarter-turn drive should not be started backward or the belt will run off; it will run in one direction only.

W. F. Schaphorst.

New York City.

Accident-Prevention Discussion

Referring to the article on accident prevention in the issue of Aug. 24, page 281, there are two statements, as follows: "Safety valves should be tested once a day to see that they are in good working order." "Steam gages and water gages should be tested from time to time to make sure they register correctly."

"From time to time" might be understood by a careless or ignorant person as meaning weekly or even monthly, while it is generally believed that the water column should be blown out every day. All engineering books emphasize the statement that "the safety valve is the most important valve in the power plant," but I think, considering the duty it performs, the water column should be recognized as being just as important an adjunct. Should the safety valve through neglect or otherwise fail to relieve a boiler of excessive pressure, an explosion will result. In case of low water, from any cause, so that a crown sheet is weakened, the result will be equally disastrous, or at least would not vary greatly.

The causes for water columns becoming plugged are too numerous to mention—from gradual accumulation of deposits of scale to sudden closure by floating substance. It should be noted that the only pressure available to force the water past an obstruction is that due to the static pressure of the water itself. This with a 12-in. difference in level would amount to less than half a pound pressure, showing how sensitive a water column is to slight obstructions, and that it should be recognized and properly taken care of.

I would greatly appreciate seeing on this subject a discussion by readers.

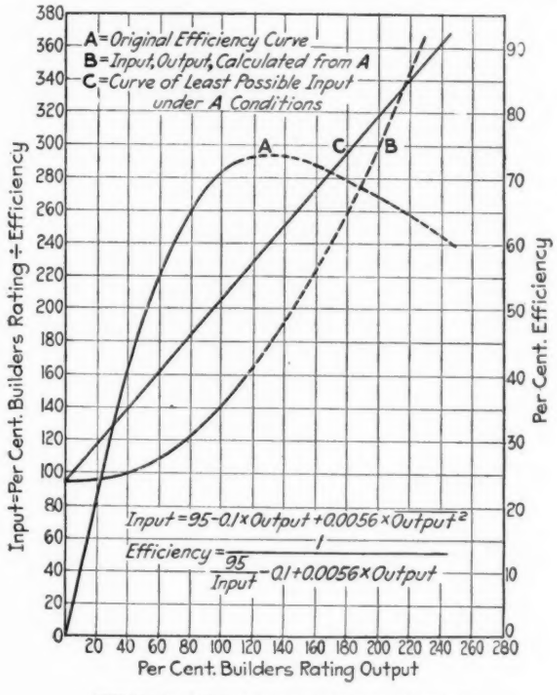
Warren D. Lewis.

Brooklyn, N. Y.

Boiler Tests at Various Loads

Messrs. Maynz and Azbe, in the Aug. 17 and Sept. 21 issues respectively, criticized an article on "Boiler Tests at Various Loads," by Charles N. Rogers, which appeared in the issue of July 20.

It has been so well demonstrated that high overload generally does not result in high operating efficiency



CURVES OF BOILER EFFICIENCIES

that further comment is unnecessary. As far back as 1906, Kent, in his "Steam Boiler Economy," discusses the point clearly, and the classical tests published concerning the Detroit Edison boilers are common evidence of the decreased combined boiler and furnace efficiency at high loads.

Mr. Rogers' chart shows only six points, and this lack of complete information leads to fallacious conclusions. In the accompanying chart Mr. Rogers' efficiency curve *A* has been copied to 110-per cent. builders' rating. From this have been calculated the inputs to the boiler and furnace by dividing the various outputs by the corresponding efficiencies. Continuing this curve *B* to zero output shows, at that point where no steam is generated, the input to equal 95 per cent. From the same curve it is evident that the coal required for keeping up steam pressure with no output would be $\frac{95}{141}$, or 67.3 per cent., of that required to generate steam at builders' rating. In other words, if a 600-hp. boiler

required 2,200 lb. of coal per hr. at 100-per cent. rating, it would require 1,480 lb. per hr. at zero load or banked. Were this generally true, 75 per cent. of the power stations would long ago have gone into bankruptcy.

With increase in loads the flue temperature increases, and with proper operation this increase is almost proportional to that in output. Consequently, the flue gas losses will have a uniform increase with load. Likewise, with proper operation, the other losses will increase accordingly; that is, as the load increases the total losses increase, and curve *B* should follow the same regular law a reasonable distance beyond 110-per cent. rating as it does up to 110-per cent., and is plotted accordingly.

From this extended curve, the maximum efficiency is found at 130-per cent. rating, while that at 200-per cent. rating is 6.5 per cent. lower. Curve *C* is plotted on the assumption that there are no added losses above zero load, even though the flue temperature and weight of flue gas increase. This shows that for Mr. Rogers' tests to be representative, the losses in the boiler and furnace when making steam would be less than when not producing it. That is, at 700-per cent. rating, the total losses are 30 per cent. less than at bank, which is absurd. Of course it is easy to imagine isolated tests where this might occur, but for good or even only fair operation the principle is not even approximately correct.

Mr. Azbe's complaint of the comparatively high furnace temperature with Mr. Rogers' underrating probably refers to flue-gas temperature, but in ordinary experience these temperatures as given by Mr. Rogers are excellent.

Mr. Azbe's statement that small boilers are less efficient than large ones is amply proved, but the merit of operating a lightly loaded plant with part banked boilers and part operated at their maximum efficiency is open to considerable doubt. It is becoming more and more a settled principle in progressive plants, where the stoking equipment will permit, to operate all boilers with the load evenly distributed. It may be impossible to follow this principle completely where there are extreme dips in the load curve, as in the case of some lighting or railway plants, but there are available stokers with a flexible and nearly perfect air- and coal-supply control which make economically desirable the elimination of banked fires unless the station load drops considerably below builders' rating.

HAYLETT O'NEILL.

Brooklyn, N. Y.

Settings for Horizontal Tubular Boiler Furnaces

I recently had the opportunity to observe some experiments that were made with a view to improving combustion and increasing the evaporation, also to determine the correct distance to set the boiler above the grates to secure the best result. The boiler was 72 in. diameter by 18 ft. long and was set 24 in. above the grate. The evaporation obtained was 4.55 lb. of water per pound of coal as fired. The smoke issuing from the stack was dense black in spite of the most careful firing, and the engineer in charge contended that the shell of the boiler, being close to the grates, acted as a condenser for the volatile matter in the coal, as the shell was comparatively cool.

For experiment, the grates were lowered to the level of the ashpit doors, a temporary ashpit and firing space being excavated, and the front of the boiler supported by a 12-in., 142-lb. beam, as a good portion of the weight of the boiler was found to rest on the front. These changes placed the boiler shell 43½ in. from the grates. The original fire-door openings were bricked up with a 4x4-in. opening left in the center for observing the combustion. This opening was covered with sheet mica to exclude the air.

The changes were made in this manner to keep the cost as low as possible, as it was not certain that they would be productive of the desired results. The engineer was subjected to much criticism and ridicule, the most vehement of the critics being an alleged consulting engineer, who only a short time before had condemned a well-known make of condenser and air-pump because it would not produce 28 in. vacuum at an elevation of 7,000 ft. above sea level.

The results after changing the setting were surprising to all. An evaporation of 7.82 lb. of water per pound of coal as fired was obtained, with a noticeable absence of smoke.

Later, an adjoining plant had occasion to install an additional steam generator, and a horizontal tubular boiler, 72 in. by 18 ft., was purchased and installed with the lowest portion of the shell 72 in. above the grate. This arrangement gave an evaporation of 9.39 lb. of water per pound of coal as fired, with an average of 13.0 per cent. CO_2, with no CO.

The coal in all three cases mentioned was Colorado bituminous run-of-mine, showing about 13,300 B.t.u., 35 per cent. volatile, and was hand-fired on stationary grates.

H. R. WASS.

Denver, Colo.

Better Make Haste Slowly with Equipment Changes

In the foreword in the issue of Aug. 10 showing a power plant with boxes and barrels labeled "Modern Apparatus" and at the side a shovel throwing parts into a junk heap labeled "Old-Fashioned Ideas and Methods," the idea suggested is, no doubt, that the power plant should be kept uptodate. This is right, but haste should be made slowly in discarding some of the old-fashioned apparatus and methods, as some of the oldest are still the best.

For instance, the screwed pipe joint can't be beat for the isolated plant by any of the newer designs that have come into use in recent years. Just suppose that when any plant is put in all the joints are welded—then think of the changes that will be made in that piping during the next ten years. Can they be made without shutting down the plant?

Some will say the screwed joint is more apt to leak and is not as strong as other styles. The quality of a screwed joint depends on skill that may be more readily attained than that necessary to make at least some of the other kinds. The strength of the screwed joint is always greater than the fitting to which it is attached, and I have known of only one that broke at the thread and this was because the pipe had been peened too much. Pipe joints of any

kind should be peened or rolled with care, as the pipe wall is easily ruined by either method. This is easily proved by taking a piece of iron or steel about ¼ in. square and peening it with a hammer on an anvil, after which it will break very easily.

For high-pressure piping up to 250 lb., the old-fashioned screwed joint, screwed through extra-heavy flanges, then faced off by taking a cut across the end of the pipe and flange, can't be beat for the isolated plant. Other old-fashioned things are good and should not be discarded and might be profitably discussed in the columns of *Power*.

H. G. Schuler.

Kansas City, Mo.

Static Effects on Lamp Filaments

It is not well known that static electricity in belts plays havoc with carbon-filament lamps. I know of a case where static electricity destroyed filament after filament, the effect being that the filament was pulled toward the belt, and as soon as it came in contact with the glass, would break. After the static troubles were removed from the belt by proper treatment, no more trouble was experienced with the lamps.

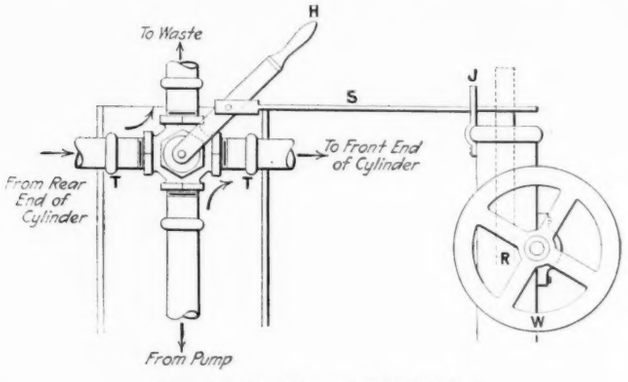
F. S. Wilson.

New York City.

Remote Control of Gas Blower

The blast for our water-gas generators is supplied by a turbine-driven fan blower. It is desirable to control the blower from the operating floor, which is in an adjoining building and one story higher than the blower. The gas-making process is intermittent, the blast being required only for five minutes out of every ten. Between blasts the speed of the turbine is reduced, but it is kept in motion so that it can be brought up to running speed in a few seconds.

As there were a number of pipes and other obstacles in the way of any system of moving levers that might



INTERLOCKING CONTROLLER

be devised, a control operated by hydraulic pressure was decided upon and was arranged as shown. A butterfly valve was inserted in the steam line near the turbine and operated by the piston of a hydraulic cylinder, which is about 8x12 in.

The water pressure for each end of this hydraulic cylinder is supplied by a pump that also operates other parts of the gas machinery and is controlled by a four-way valve in the operating room. The four-way valve is operated by the hand lever *H* which, in the position shown, conducts the water pressure to one end of the cylinder, closing the butterfly valve and slowing down the turbine, which is, however, kept at a slow speed by steam through a small bypass. Reversing the four-way cock shifts the water pressure to the other end of the cylinder, thereby opening the butterfly.

The connecting-rod *S* is a safety device connected with the generator blast valve, which is operated by a hand-wheel *W*, pinion and rack. It is necessary that the blower be up to speed whenever this blast valve is open; otherwise combustible gas might come from the gas generator into the blast main, resulting in the formation of an explosive mixture.

When the controlling lever is in the position shown the rack cannot be raised; therefore the generator blast valve cannot be opened, and when the blast valve is open the four-way valve cannot be shifted to the slow-speed position because the rack extends several inches above when open, indicated by the dotted lines. Only when the handle *H* is moved over to the speed position can the rack *R* come up and the generator valve open.

William A. Dunkley.

Atlantic City, N. J.

Air Leak in Condenser System

An air leak developed in the condensing system of a 1,000-kw. turbine. The vacuum gage from day to day showed a gradual drop, and search was made to locate the cause. All the customary methods of detecting air leaks were used in every suspected place.

The one place overlooked was the expansion joint on the equalizer pipe, which was thought to be above suspicion and was only discovered by accident to be in very bad shape, the copper having cracked in several places.

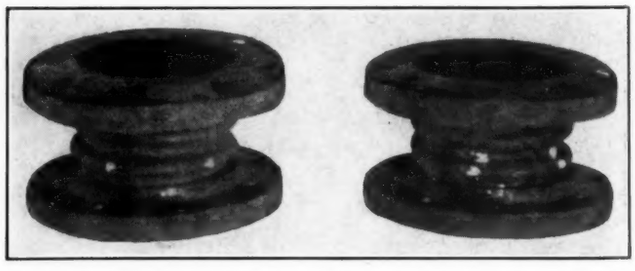


FIG. 1. EXTENT OF CRACK ON ONE SIDE

FIG. 2. TWO ON OPPOSITE SIDE

It was not thought expedient to remove the expansion joint and solder or braze the cracks; but temporary repairs were made until a new one could be secured from the factory. The joint was painted with a thick coating of orange shellac and bound with friction tape. This proved satisfactory, raising the vacuum to within $\frac{4}{10}$ in. of normal.

The illustrations show between chalk marks where the cracks occurred—one in Fig. 1 and two on the opposite side, shown in Fig. 2. This experience demonstrates that one must be careful and thorough in inspection work of this kind.

Francis McCough, Jr.

Albuquerque, N. M.

Inquiries of General Interest

Temperature of Ignition of Coal Dust—What is the temperature of ignition of bituminous coal dust?

J. A. M.

The dust ignites at temperatures about 750 deg. F., provided there is enough heat present to ignite a sufficient quantity for passing along the heat of combustion to adjacent particles so as to make the ignition continuous.

Increasing Travel of Valve—How can the travel of a valve be increased without altering the throw of the eccentric?

M. M.

In engines having the valve moved by a rocker-arm that receives motion from the eccentric rod, the valve travel can be increased by reducing the radius of the eccentric-rod rocker-arm or increasing the radius of the valve-rod rocker-arm.

Power Required at Low Power Factor—Is more power required for a given load at a low power factor than at a high power factor?

M. C. G.

Practically no more power is required of the engine for driving the generator, though a heavier current is necessary, part of which is wattless and does no work and tends to heat the generator windings and the feeders. Since the capacity of a machine is limited by its heating, a low power factor reduces the capacity of the generator.

Lap of Steam Valves of Duplex Pump—Why are the steam valves of a duplex pump made without lap?

H. O. D.

The slide valves of a duplex pump usually are made with a very small lap, though generally not more than $\frac{1}{16}$ in., so as to cover any irregularities of the edges of the ports. Additional lap is not given, as it increases the chance of the pump's stopping in a position where all ports would be covered and from which the pump could not be started by admission of steam to the steam chest.

Ratio of Air Used to Theoretical Requirement—Knowing from a flue-gas analysis the percentages of CO_2, O, CO and N, how is the ratio found of air used to the theoretical quantity of air required?

R. L. B.

The ratio of the air actually supplied per pound of fuel to that theoretically required to burn it is:

$$\frac{3.036\left(\frac{N}{CO_2 + CO}\right) \times C}{34.56\left(\frac{C}{3} + H - \frac{O}{8}\right)}$$

in which N, CO_2 and CO respectively are the percentages by volume of nitrogen, carbon dioxide and carbon monoxide in the flue gases, and C the percentage by weight of carbon which is burned from the fuel and passes up the stack as flue gas.

Velocity of Discharge from Blowoff Valve—What would be the velocity of discharge from a blowoff valve in blowing down a boiler under 125 lb. gage pressure against a back pressure of 40 ft. head?

R. L.

A pressure of 125 lb. per sq.in. would be equivalent to $125 \times 2.3 = 287.5$ ft. head, and discharging against 40 ft. head the net head would be $287.5 - 40 = 237.5$ ft. The theoretical velocity would be given by the equation

$$v = \sqrt{2gh}$$

in which

v = Velocity in feet per second;
g = 32.16, the acceleration of gravity;
h = 237.5 ft.

or by substituting,

$$v = \sqrt{2 \times 32.16 \times 237.5} = 123.5 \text{ ft. per sec.}$$

Ordinarily the actual velocity and discharge would be about 62 per cent. of the theoretical, depending on the form of the passages through the valve; that is, the actual velocity would be about 76 ft. per sec.

Heat Lost from Moisture in Air Supply—In using coal containing 14,240 B.t.u. per lb. and 21.3 lb. of air per lb. of coal, what percentage of the heat value of the coal is lost from moisture in air supplied to a boiler furnace at 60 deg. F. and having relative humidity of 60 per cent., if the furnace gases are discharged from the boiler uptake at 560 deg. F.?

D. S.

A pound of air at 60 deg. F. and at atmospheric pressure, when saturated with moisture, contains about 0.012 lb. of vapor, or for 60 per cent. saturation a pound of air would contain about 0.0072 lb. and therefore the weight of vapor carried would be $21.3 \times 0.0072 = 0.153$ for each pound of coal. The average specific heat of the vapor between the temperatures 60 deg. F and 560 deg. F. would be about 0.48, and therefore with coal containing 14,240 B.t.u. per lb. the loss in percentage of the heat value of the coal due to the presence of moisture in the air would be

$$\frac{0.153 \times (560 - 60) \times 0.48 \times 100}{14{,}240} = \text{about } \tfrac{1}{4} \text{ of 1 per cent.}$$

Effect of Air Velocity on Hygrometer—What effect has velocity of the surrounding air on the indications of dry- and wet-bulb thermometer instruments employed for determining the percentage of humidity of atmospheric air?

W. R. J.

With circulation of the air, evaporation occurs more rapidly from the moistened bulb of the wet-bulb thermometer and its temperature will thereby be lower than when the instrument is placed in the same air when at rest. Therefore, if the thermometer readings taken in an air current are referred to a chart or table intended for interpretation of readings made in still air, the indicated percentage would be lower than the actual percentage of humidity. On the other hand, if readings taken in still air are referred to a chart or table intended for use with a ventilated exposure of the instrument, then the interpreted percentage of humidity would be too high.

The charts or tables which accompany most hygrometers are intended for interpretation of indications of the instruments when used in air currents above about 10 ft. per sec., and the rate of ventilation makes little difference so long as it is kept above that velocity. For use of these instruments in unventilated atmospheres, readings of the wet-bulb thermometer can be obtained which are correct for use with the tables or charts intended for a ventilated atmosphere by vigorously fanning the instrument.

Using Indicator on Drip-Cock Connections—We have an old-style slide-valve mill engine, also a hoisting engine and compressor, none of which is tapped for taking indicator diagrams in the usual way, though they have the usual drip-cocks. By using an indicator on the drip-cock connections could diagrams be taken which would, in a measure, be a guide as to the setting of the valves, etc.?

A. N.

Drip-cock connections will answer provided they are not less than ½ in. and the connection to the indicator is kept clear of water. This can be done by supplying the engine with dry steam and warming the engine thoroughly and dripping the connections just prior to taking a diagram. But for proper drainage dependence should not be placed solely on that which is afforded by the ordinary indicator cock. The indicator connection should be made close to the engine cylinder and taken out of the side of a tee placed in the drip connection; and the latter should be continued beyond the tee with a full-sized nipple and drip-cock, so the extension may afford a space for holding any water received from the cylinder of the engine while taking a diagram. A slight error will be introduced from thus increasing the clearance space of the engine, and therefore the connections should be no longer than necessary; but with the connections properly arranged and manipulated to prevent water from interfering with the operation of the indicator, diagrams can be obtained that will be sufficiently reliable for most practical purposes.

[Correspondents sending us inquiries should sign their communications with full names and post-office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Stopping Pulsations in the Feed Line

By Alan A. Wood

SYNOPSIS—Pulsations in the feed line are quite common. Unfortunately, these seriously affect the water meters on the lines. The author here tells of . . how erratic meter readings were before special air chambers (described previously in Power*) were applied to take out the pulsations. Here is an easy solution of pulsation troubles.*

Unusual connection of piping and peculiar arrangement of feed pump presented an interesting problem to the engineers of the Puget Sound Traction, Light & Power Co., Seattle, in the measurement of the feed water at the Pond Street plant. There are six 500-hp. boilers operated at 150 per cent. of rating. It will be noted by referring to Fig. 1 that the feed water is taken from a large cistern by two 20x15x15-in. duplex pumps working against 90 lb. pressure. The two 6-in. discharge lines from these pumps deliver to the suction of three 10x6x12-in. duplex pumps and one 7x12-in. triplex which boost the water into the boilers against 180 lb. pressure.

There are on one of the duplex feed lines two auxiliary heaters, which can be used with economy under certain conditions, so that to provide adequate measuring facilities it was at first thought necessary to have a meter on each line. It was also realized that the meters would be subjected to the water hammer and pulsations from the discharge of the big pumps and a similar action from the suction of the small pumps. Although the pumps are well-maintained, the conditions presented by this arrangement imply considerable wear and tear on the feed line, check valves, etc., with consequent frequent blowing out of gaskets; also, the manufacturers of boiler-feed meters refused to guarantee accurate measurement under these conditions, since it has been determined that pulsating flows do not follow any fixed or simple law.

Experiments were made, however, with one meter with no air chamber or surge tank to absorb the pulsations.

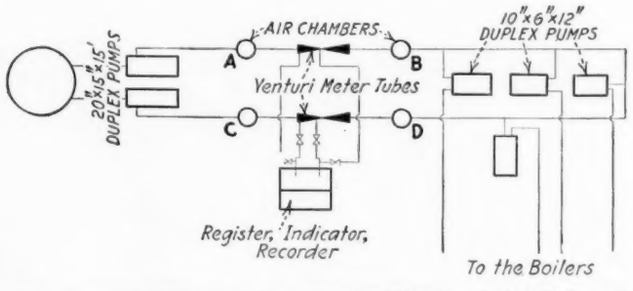


FIG 1. VENTURI METER CONNECTIONS, SHOWING AIR CHAMBER LOCATIONS TO PREVENT PIPE-LINE PULSATIONS

The results were so erratic and inconsistent that this method was condemned as impractical.

The second method was as follows: A venturi meter tube was placed in each of the two 6-in. lines . Both tubes were connected to the same register-indicator-recorder, obviating the necessity of having two complete meters; see Fig. 1. The lines at this point are made to run in a vertical direction. It was recognized that there are two sources of pulsations from the pumps and that to obtain a steady flow through the meter tube it would be necessary to place an air chamber in each 6-in. line ahead of the meter tube, and another following the meter tube. These air chambers are of the type described by Charles G. Richardson in *Power,* July 18, 1913.

It will be noticed that the air chamber is constructed in two parts, the lower section a special casting similar to a tee, the upper part the air reservoir. On the interior of the lower casting is a vertical baffle plate, the purpose of which is to divert the flowing water against the air in the chamber proper. Were dependence placed upon the

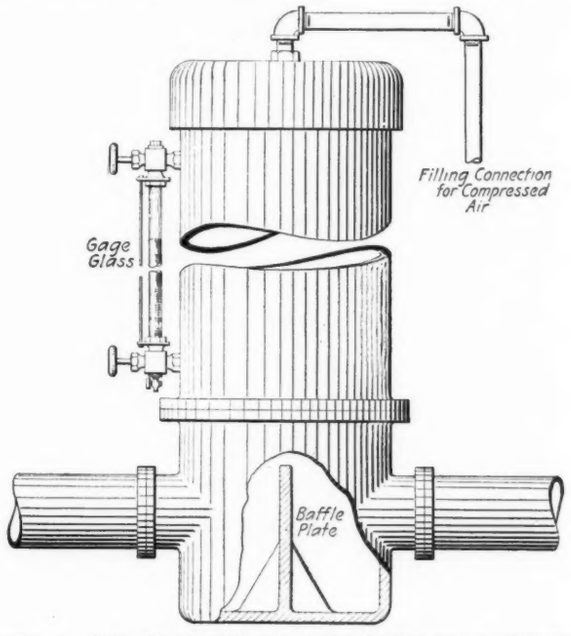


FIG. 2. AIR CHAMBER TO OVERCOME PULSATIONS IN PIPE

air arising from the water or filling the chamber from the atmosphere by suction, the chamber would probably be filled to only a fraction of its volume. Therefore provision was made to charge the chamber with compressed air from an outside connection.

The action of the chamber is as follows: Each forward stroke of the pump imparts energy to the water. This is not entirely used in forcing the water toward the boilers against steam pressure. On its path to the boilers the advancing slug of water encounters the baffle plate, which diverts it against the air in the chamber. The air undergoes compression and stores up the energy given it. On the return stroke of the pump this energy is returned to the water. Consequently the flow is kept uniform and free from pulsations after passing the chamber. There is a gage-glass showing the depth of air in the chamber.

The chambers on the suction of the small pumps are identical in design and similar in action except that the cushioning effect is obtained before the water enters the chamber, the latter answering in some degree the functions of a suction tank.

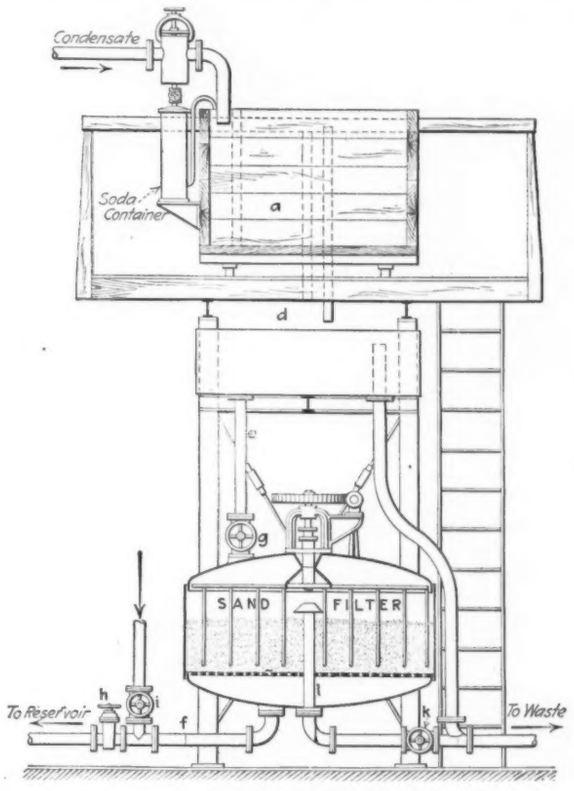
The Reubold Electrolytic Condensate Purifier

Oil in the condensate takes either the form of small drops or of what is called an emulsion, which to all appearances is identical with a solution. While minute oil drops will collect at the surface of the water if the latter is allowed to stand, the particles of an oil emulsion cannot thus be removed. When the water is re-evaporated in the boiler they will settle on the heating surfaces, opposing the transmission of heat and tending to cause overheating of the metal. Even when separators are used there often remain traces of oil. Electrolytic purification, however, is claimed to do away with all the oil.

The Reubold electrolytic purifier, designed by Messrs. Hannoversche Maschinenbau, A. G., of Hanover, Germany, comprises two spiral electrodes between which the water is made to pass. The electric current causes the emulsion to coagulate, the oil being separated in the form of small flakes retained by a fine-gravel filter, while the purified water continues to the feed-water tank. Direct current is required, the consumption being about 0.2 kw.-hr. per cu.m. of water.

Referring to the illustration, the water is delivered by the condensate pump into the compartment *a*, which contains the spirally arranged electrodes. Since, apart from the oil particles, the condensate contains practically no chemical admixtures, its conductivity is improved by the addition of soda, for which purpose a distributor is placed in the supply line. After passing through the electrodes, the water with the separated oil flakes flows through the pipe *d* into the receiver, thence through the pipe *e* into the gravel filter, where the oil particles are separated out; the clear water then flows through the pipe *f* into the feed-water tank.

The gravel charge of the filter should be washed periodically, depending upon the load on the apparatus. This washing is effected by closing the valves *g* and *h* and opening the valves *i* and *k*, thus reversing the flow through the gravel and bringing the oil particles to the surface. These



SECTIONAL ELEVATION OF PURIFIER

are led off to the sewer through the pipe *l*. In order to make the washing of the gravel effective, a stirring device is employed.

Washing Smoke from Locomotives*

By M. D. Franey†

SYNOPSIS—Description of a smoke washer giving commendable results at the round house, Englewood Station, a residential section of Chicago. The washer would of course be equally well suited to stationary requirements. To avoid the injurious effects of acids produced by the smoke and water, the concrete washer tank is lined with dressed lumber and tar held by wooden pins instead of nails. The cost of operating the washer is given.

O. M. Webster, master mechanic in this territory, after a careful study of smoke-washing devices, decided to force the smoke through a large body of water by means of a fan, separating the unconsumed carbons from the gases, permitting the latter to escape through a high stack and holding the carbons and other solids in suspension in the water. This was for the new engine house at Englewood, a residential section of Chicago. A small plant capable of taking care of one locomotive was built at Elkhart, Ind., and this gave results beyond expectations.

The Englewood engine house contains 30 stalls, in which from 80 to 100 locomotives are handled per day of 24 hr. This house is built without a smoke-jack leading direct to the atmosphere. In washing the smoke a concrete tank, 22x32 ft. and subdivided by separating walls into three basins, is used. Each basin is lined on the interior with dressed lumber set about 1½ in. from the concrete, the space between the concrete and the lining being filled with tar. Wooden pins, instead of nails, are used for fastening the lining, so as to resist the action of the acids. Fig. 1 shows a section through the engine house and washer and Fig. 2 a plan of the fan, discharge ducts and washer tank.

A smoke duct 60 in. diameter at the center and tapering off to 36 in. at the end extends around the house just under the roof and directly above the smoke-stacks of the locomotives when the latter are headed in and standing in normal position. This smoke duct was built of transite[1] material and connected with a drop pipe leading on each pit. In each of these drop pipes a damper was built, with a mechanism for opening and closing. Leading down from each drop pipe is a cast-iron telescopic jack supported from the roof. The lower end of the jack is provided with a conical hood to fit over the stack of the locomotive. These jacks have vertical, lateral and longitudinal movement to accommodate different positions of the locomotive stack. The jacks are raised and lowered by a walking beam counterbalanced with a weight and operated from the wall of the engine house, as shown in Fig. 1. The damper is opened and closed from this same point.

*Read before the International Association for the Prevention of Smoke, Cincinnati, Sept. 9.

†Master mechanic, Lake Shore & Michigan Southern R.R., Michigan Southern Division.

[1]Transite: A hard, fireproof, asbestos-like material.

Near the center of the house a large elbow connects into the top of the 60-in. duct and leads down to a 78-in. steel-plate double-inlet fan capable of handling 68,000 cu.ft. of 500-deg. F. gases per minute at a total static pressure of 14-in. at the fan outlet and at a speed of 950 r.p.m. The fan is beltdriven by a 300-hp. constant speed 300-400 r.p.m. motor. A smoke duct leads from the fan to each of the three concrete basins, the outlet to each duct coming directly under the hoods already referred to, and shown in Fig. 1. There are three hoods in each tank. The top of the interior or smallest hood is open, while the top of the second one is closed similar to a bell, and the top of the third or outer hood is open and connects with the stack, which is approximately 60 ft. high. The three smoke ducts leading from the fan, the hoods and the stack are made of wood pinned together with wooden pegs. The lower portion of the three hoods extend down in the concrete basin and are submerged in the water.

An 8-in. hole is provided in each of the separating walls to insure a uniform level of water in the three basins. A special overflow pipe is provided to maintain 14 in. of water in the tanks and to prevent the carbons from escaping into the sewer. A 1¼-in. high-pressure steam jet, with a 10-in. radius elbow and a nozzle pointing toward the outlet, is located in each of the three ducts and close to the concrete tank, as shown in the detail, Fig. 2. The purpose of these jets is to accelerate and thoroughly mix the gases with the water and prevent them from passing through the water in large bubbles.

In operation, the telescopic jacks that are not connected with a locomotive having a fire in it have the dampers closed. Locomotives with a fire have the jacks closed on top of the locomotive stack and the dampers opened.

In starting new fires it is necessary to use the house blower slightly—this to assist the action of the fan, especially at extreme ends of the house. The gases are drawn through the jacks, duct and the large elbow, into the fan, from which they are forced through the three smoke ducts, through the water, passing out into the first hood. As they enter tanks the gases are accelerated by the steam jets and engulfed by the spray and wave action of the water, passing out through the top of the first into the second hood, or bell, which has a closed top. They are forced down below the lower edge of the bell, passing between the second and the third hood, and out into the stack.

The carbons and solids are separated from the gases by repeated washings, and rise to the top of the water in the tank in the form of a black, foamy scum. The gases pass out through the stack as a white vapor. In handling 80 locomotives per 24 hr., from 8 to 10 bbl. of carbon is obtained from the washer. This has the appearance of lampblack and is thoroughly steam-dried after it is taken from the smoke washer. An analysis of this material shows the following:

Substance	Per Cent.	Substance	Per Cent.
Moisture	3.9	Iron oxide	8.7
Carbon	82.6	Silica	1.8
Sulphur	2.6	Calcium oxide	Trace

The sulphur and sulphuric acids are retained in the water, and the gases that pass out through the stack are practically odorless. The Smoke Department of the City of Chicago and the near-by residents are well pleased with the results obtained.

COST OF THE WASHER

It is estimated that the cost of making an installation as described would be from $15,000 to $18,000 where the property conditions are favorable. Owing to the property conditions and to the fact that this plant is an experimental one, the actual cost was somewhat greater.

The cost of operation is as follows:

COST OF OPERATION PER DAY OF 24 HOURS

Water, 18,255 gal, @7c. per M	$1.28
Coal, 10.86 tons, @ $1.75 per ton	19.00
Electricity, 3,360 kw.-hr., @ $0.0129	43.34
Total	$63.62

SAVING EFFECTED BY THE USE OF WASHER PER DAY OF 24 HOURS

Fires maintained	$40.80
New fires built	7.11
Reduced electrical cost due to sliding scale rate	8.52
Total	$56.43

This makes the net cost of operating the washer $7.19 per day of 24 hr. It is expected that we will be able to find a profitable use for the lampblack reclaimed, and this would of course result in still further decreasing the net cost of operation and possibly show a profit.

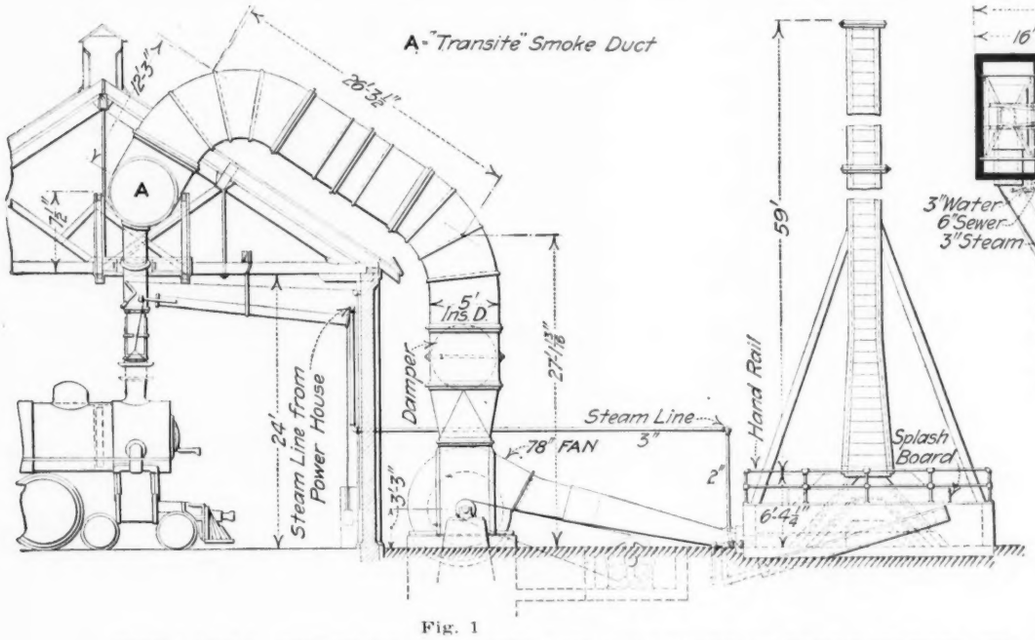


Fig. 1

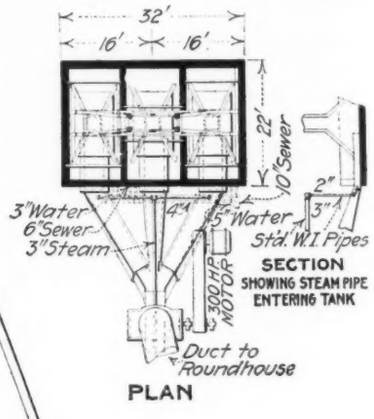


Fig. 2

FIGS. 1 AND 2. SECTIONAL ELEVATION AND PLAN VIEWS OF SMOKE WASHER FOR ROUNDHOUSE

Tests show that the coal and water consumption is materially reduced on engines stored under the smoke-jack and influenced by the draft of the smoke-washer fan. The temperature of the firebox is uniform, and the fire-up man is able to handle a larger number of locomotives than when stored outside the house. For parts of the washer in contact with water treated wood will hereafter be used as concrete and metal quickly deteriorate.

This smoke washer is operated under patent controlled by the American Smoke Washing Co., incorporated in the State of Illinois; S. K. Dickerson, 5120 Greenwood Ave., Chicago, secretary.

With the Increasing Use of Acetylene Gas the risks of its corrosive effect on pipes and metal containers should be better known. Tests have shown that moist acetylene, as generated, attacked zinc, lead, brass and nickel to a slight extent; iron was affected six to seven times as much; but copper suffered more than any other metal tested. Copper was quickly changed into a soft, porous black mass. Tin, aluminum, bronze, german silver and solder were practically unaffected. Thus it would appear that copper and brass or other copper alloys should not be used as piping for acetylene-gas supplies, and that iron should be well tinned rather than galvanized or nickel-plated.

The decrease in the production of anthracite was due in part to mild weather during the winter in the area where it is used almost exclusively for a domestic fuel and in part to decrease exports to Canada.

The total production of bituminous coal and lignite decreased from 478,435,297 short tons in 1913, valued at $565,234,925, to 422,703,970 tons in 1914, valued at $493,309,244.

The decrease in production of bituminous coal was generally distributed over the country, but there were seven states in which the production in 1914 was greater than in 1913. Two of these states, North Dakota and South Dakota, produce lignite only and make a relatively small output. New Mexico's increase was due to ability to supply markets ordinarily furnished by coal from Colorado, which in 1914 suffered from a serious strike. The other states that showed an increase were West Virginia, Kentucky, Michigan and Oregon. The greatest decrease was in Pennsylvania, whose output fell off almost 26,000,000 tons. The greatest decrease expressed in percentage was in Ohio, where because of strikes the decrease was over 17,300,000 tons, or nearly half, as compared with 1913.

Spray Cooling Systems*

By Lee H. Parker†

The pollution of river water by waste products from manufacturing processes, thereby rendering it unfit for use in condensers, led to the English practice of constructing cooling ponds from which condensing water was drawn and to which the hot water from condensers was returned, thus using the water over and over again. In order to utilize the surface of the pond as efficiently as possible a series of partitions was arranged so as to cause the incoming hot water to travel over the entire area of the pond before reaching the point from which the supply for the condenser was drawn. Some ponds of this character are still in use in this country.

Natural ponds, sometimes used for cooling purposes, were equipped with wooden troughs constructed so as to deliver the hot water at a considerable distance from the intake well. As the cooling obtained with such ponds was small except in winter, other devices were sometimes added in an attempt to increase the cooling, such as a rack at one end of the pond filled with brush, on top of which the hot water was discharged, or a series of low towers with grillwork.

Later, so-called natural-draft cooling towers were developed, consisting of a structure filled with grillwork for breaking up the water into drops on its passage from a system of distributing troughs on top to a basin below, a current of air being induced through the structure by means of a chimney. The typical forced-draft cooling tower consists of a circular steel shell filled with small drain tile or other material arranged to present a large surface for water distribution and contact with air, which is forced through the tower by large disk fans placed at the base of the tower and generally driven by motors.

APPLICATION OF A SPRAY COOLING SYSTEM

The cooling ponds often found near cotton mills are easily adapted to spray cooling by the extension over the pond of the condenser discharge piping. This is supported on wooden bents or concrete piers, with a sufficient number of properly designed spray nozzles arranged at the right distance with relation to one another and the correct height above the surface of the pond to bring the sprayed water into contact with a sufficient amount of air to produce the necessary cooling effect. The pressure required at the nozzles is only from 5 to 7 lb., and in many cases the condenser already in use is able to discharge the water against this pressure plus the pipe friction between the condenser and nozzles, provided the system is correctly designed. In case the condenser cannot do this, or is of the barometric type discharging the water into a hotwell, then an auxiliary pump can be used to take the water from the hotwell and deliver it to the spray system at the proper pressure. Such a pump is generally of the centrifugal type, either direct-connected or belted to a motor or other prime mover, such as a small steam turbine, engine or countershaft.

The most important parts of a spray cooling system are the spray nozzles. Their function is to produce a fine uniform spray at low operating pressure without clogging. They are provided with removable turbine centers having large passageways. These centers are held stationary in the nozzles so that the water in passing through is given a rapid rotary motion. A central driving jet, which impinges on the rotating water at the orifice, causes it to be ejected as a fine, dense, uniform spray. The nozzles are made of high-grade bronze finished smooth inside and out. The piping is generally of cast iron with flanged connections, valves and fittings.

COMPARISON OF SPRAY AND OTHER SYSTEMS

Careful tests extending over a period of several weeks have shown that the average amount of heat dissipated from the surface of a natural cooling pond with partitions arranged so incoming hot water travels over the entire area of the pond before being returned to the condenser was 3.5 B.t.u. per sq.ft. per hr. per 1 deg. difference, and that the average heat dissipated by a spray cooling pond was 127 B.t.u. per sq.ft. per hr. per 1 deg. difference, or approximately 36 times as much. This shows that the capacity of a cooling pond can be increased greatly by the addition of a spray cooling system.

It is important to have the ratio of condensing water to steam condensed large enough to keep the water in the pond in equilibrium for any desired vacuum. If this ratio is such that the heating effect of the condenser is greater than the desired cooling effect of the pond, the temperature of the latter will rise and the vacuum will decrease a corresponding amount, thus impairing the economical operation of the engine or turbine.

With a spray cooling system when there is no breeze, an effective upward current of air is created around each nozzle, due to the movement of the spray as well as to the heating effect which the spray has on the air in contact with the water. This current rapidly carries away the warm moist air produced and replaces it with cool dry air brought in from all sides over the surface of the pond.

Spray cooling ponds are more efficient in extremely hot weather when high humidity prevails than in cool weather with low humidity.

Some results obtained with spray cooling systems follow. These were obtained in an artificial pond at a New England cotton mill having 4,000 hp. of Corliss engines. The pressure at the nozzles was 6 lb.:

COOLING OBTAINED AT DIFFERENT SEASONS

Time	Temperature Air Deg. F.	Relative Humidity per cent.	Temperature of Water Before Spraying Deg. F.	Temperature of Water After Spraying Deg. F.	Vacuum Obtained In. Mercury	Average Barometer In. Mercury
TYPICAL WINTER DAY						
7 a.m.	16	..	90	57		
8	18	72	100	60		
9	20	..	104	63		
10	22	..	105	64	A very low ratio of	
11	24	..	107	65	circulating water to	
11.45	26	..	108	66	condensed steam	
1.15 p.m.	28	..	108	64	used in winter.	
2	30	..	110	66		
3	31	..	110	66		
4	30	..	110	67		
5	28	..	112	67		
TYPICAL SPRING DAY						
7 a.m.	56	..	99	82	28.30	....
8	59	79	100	85	28.30	30.35
9	62	..	101	86	28.20	....
10	64	..	103	88	28.15	....
11	66	..	104	88	28.15	....
12	68	..	104	90	28.05	....
1 p.m.	70	..	104	87	28.00	....
2	72	..	104	88	28.05	....
3	74	..	104	88	28.05	....
4	73	..	104	88	28.05	....
5	70	..	105	88	28.05	....
TYPICAL SUMMER DAY						
7 a.m.	69	..	104	87	27.90	....
8	71	40	108	92	27.50	30.05
9	75	..	110	94	27.45	....
10	78	..	112	96	27.25	....
11	85	..	113	98	27.25	....
11.45	88	..	114	98	27.10	....
1.15 p.m.	90	..	112	98	27.25	....
2	92	..	113	96	27.25	....
3	93	..	113	96	27.25	....
4	93	..	113	97	27.20	....
5	92	..	113	98	27.20	....

The results cited were obtained with single spraying, that is, spraying the discharge water only once before returning it to the condenser. Greatly increased cooling effects can be obtained by two or more separate and successive sprayings, or by multiple spraying, which consists of mixing a portion of the cooled water from the pond with the hot water in the discharge line and spraying the mixture at the resulting average temperature.

In order to determine whether the installation of a cooling system is warranted or not in any special case, it is only necessary to compare the cost of city water used for condensing purposes, or the cost of pumping if water is obtained

*From a paper delivered before the National Association of Cotton Manufacturers, New London, Conn., September, 1915.

†President, Spray Engineering Co.

from a more or less distant river, pond or wells of any kind, with the fixed charges on the first cost of a cooling system, plus the costs of operation and maintenance.

As spray cooling systems under average conditions have lower first cost, require less power for operation and practically no maintenance as compared with well-designed and constructed cooling towers, they are being used to a constantly increasing extent in connection with cotton mills, except in cases where sufficient pond area is not available either on the ground or on roofs of buildings adjacent to the condensing installation. This latter condition, however, rarely occurs in the case of cotton mills and their allied industries.

Heating of Iron at High Frequencies

In a recent paper before the British Association for the Advancement of Science, N. W. McLachlan described experiments illustrating the heat produced when iron is magnetized by very high-frequency alternating-currents—2×10^5 to 5×10^5 cycles. The magnetizing current is obtained by using a Poulsen-arc generator across the town mains (240 volts). In order to demonstrate the extent of the losses, a magnetic heater, or boiler, consisting of a solenoid wound on a glass tube containing water and a number of iron strips or wires, is inserted in the shunt circuit of the generator. A short time after the shunt circuit is closed the water begins to boil.

An experiment was also arranged to show the variation in permeability of iron with variation in temperature. A ring of mild steel is insulated with asbestos and wound with a number of turns of copper wire. This is connected in the shunt circuit of the generator. By passing a large current through the winding of the ring, thereby obtaining a strong magnetizing force, the magnetization losses are such that a rapid rise in temperature is produced, causing the iron to attain a bright-red heat. The variation in permeability corresponding to the rise in temperature may be followed by observing the current in the shunt circuit and the voltage across the terminals of the ring. Data were given which enabled the changes to be followed.

Two- vs. Four-Stroke-Cycle Marine Diesel Engine

Some of the relative advantages of two- and four-stroke-cycle Diesel engines for marine work and their present limitations in size and speed are contained in a paper by G. C. Davison, of the New London Ship and Engine Co., read at the recent International Engineering Congress in San Francisco. The following is in substance the author's remarks on this subject:

It is apparent that there exists today a certain difference of opinion as regards the merits of the two- and the four-stroke-cycle Diesel engines. While there are more firms building two-stroke-cycle engines, at the same time those building four-stroke-cycle engines seem to have met with more success. The two-stroke-cycle engine superficially has the advantage of developing double the power for a given size of cylinder. It gives one impulse each revolution, while a four-stroke-cycle engine requires two revolutions for one impulse. It may seem that the former should therefore furnish twice the power for an engine of given size. This, however, is far from realization. In order to operate on the two-stroke-cycle principle a scavenging air system has to be provided. This requires considerable space and weight and a large number of additional working parts. The net result is that after adding the scavenging system the two-stroke-cycle engine occupies nearly the same volumetric space as the four-stroke-cycle engine and is only slightly lighter.

Another advantage of the two-stroke-cycle engine is that with a given number of cylinders a more even turning movement is obtained, consequently a lighter flywheel can be used; in fact, with six or eight cylinders in a high-speed engine of this type, the flywheel can almost be dispensed with. Also the reversing of a two-stroke-cycle engine is much simpler than that of a four-stroke-cycle. The same set of cams can be used for both the ahead and the astern motion. Moreover, inertia forces in two-stroke-cycle engines are masked by the pressure in the cylinders, so that stresses on the main-bearing caps and connecting-rod bolts are very small as compared with those in a four-stroke-cycle engine.

The two-stroke-cycle engine has no mechanically operated exhaust valves, as the exhaust occurs through ports in the cylinder wall, which are uncovered at the end of the stroke by the piston. In the four-stroke-cycle type, the mechanically operated exhaust valve is exposed to hot gases and is the source of more or less trouble.

The four-stroke-cycle engine has certain advantages of its own. It is simpler and each cylinder comes nearer to becoming a complete unit than in the case of the two-stroke-cycle. As regards the number of parts, it has not only a less number of different parts, but also a less number of total parts, making it mechanically simpler. Also it is far superior in the heat conditions, as it handles only half the amount of heat developed in a two-stroke-cycle engine of the same dimensions. Consequently, for cylinders below a certain size it does not require artificial cooling of the piston, as is necessary in the two-stroke-cycle type. In the larger sizes piston cooling is necessary in both types, but the four-stroke-cycle has the advantage of working with a much lower mean temperature, consequently there is less likelihood of cracks due to heat conditions. Moreover, it is more economical than the two-stroke-cycle.

Limitations in Engine Sizes

There are certain limitations to the size of Diesel engines which may be advantageously applied to marine propulsion. The smallest that can well be used is in the neighborhood of 100 hp. As compared with gasoline engines the first cost of a Diesel of small power is such that below this limit the saving in cost of fuel is sufficient only to offset the interest and depreciation. As the size increases, the economy in fuel becomes of greater importance. The upper limit of size is at present fixed by the designs and materials now in use and is approximately 400 hp. per cylinder in single-acting units. That is, this represents about the upper limit of engines that have been built and are in successful operation. Experiments have been made, however, on double-acting two-stroke-cycle engines developing 2,000 hp. per cylinder, which represents about the theoretical limit unless some radical departure is made.

Marine Diesel engines may be roughly divided into two general classes, according to weight per horsepower. The light-weight class is represented by the engines used in submarines, which run at piston speeds from 1,000 to 1,200 ft. per min. A 1,000-hp. 6-cylinder engine will in some cases run as high as 450 r.p.m. and will weigh approximately 40 lb. per hp.

A heavy-duty slow-speed engine developing 1,000 hp. at 100 r.p.m. will weigh as much as 300 lb. per hp. Intermediate types are also built; for instance, the 1,000-hp. Nuremberg engine of the U. S. S.S. "Fulton," running at 260 r.p.m., weighs 100 lb. per hp.

About 300 Diesel engines were built for submarines previous to the present war; since the war began a large number have been built or are building, the sizes ranging from 300 to 1,000 hp. Destroyers require such enormous power (from 10,000 to 15,000 hp.) that it is not practical, at least at present, to install Diesel engines to give this output. Certain foreign countries have, however, installed both steam turbines and oil engines in destroyers. For ordinary cruising the Diesel engine is used, thereby effecting great economy in fuel, and for high speed, the turbine.

The United States Navy is now building the fuel ship "Maumee," to be equipped with two Nuremberg two-stroke-cycle Diesel engines, developing about 2,500 hp. each. These will be the largest slow-speed heavy-duty engines thus far attempted. For commercial work marine engines from 50 to 2,400 hp. are in regular operation.

A further development, yet in its infancy, is the double-acting two-stroke-cycle Diesel. Prior to the European war the Nuremberg Co. had been working for over four years on a 6-cylinder double-acting two-stroke-cycle engine of 12,000 hp. This was reported to have been completed last summer.

Economic Outlook for Marine Diesels

There has always been a difference between the European and the American point of view, due to conditions. Up to within the past year capital was comparatively plentiful in Europe and fuel scarce. Consequently the European shipowner considered ultimate saving and was willing to pay a greater first cost for his propelling plant if the operating economy would show an ultimate gain. In the United States the shipping business has never been given much encouragement and those who have gone into the business have had to consider first costs very seriously. Furthermore, both coal and oil are comparatively cheap in this country. Finally, a further drawback to American development has been the lack of trained operators. In the course of time the basic advantages will be realized in this country and the necessary trained operators will be developed. Under present circum-

stances it is impossible to install a Diesel engine plant at the same cost as a steam plant. There is a possibility that there may eventually be developed a Diesel engine which will cost so little more than a steam plant that the difference will not be worth serious consideration. When that time comes we shall probably see a boom in the marine Diesel-engine business.

Probably the worst enemies of the marine Diesel engines during the past few years have been its over-enthusiastic advocates, many of whom have made promises that they could not fulfill. Others have built and installed engines that were nothing but experiments. New firms are continually entering the field, little realizing that the design and construction of these engines are highly developed specialties. The first ones produced in this way are generally failures and unfortunately the good and the bad suffer as a result.

Another Edison Anniversary

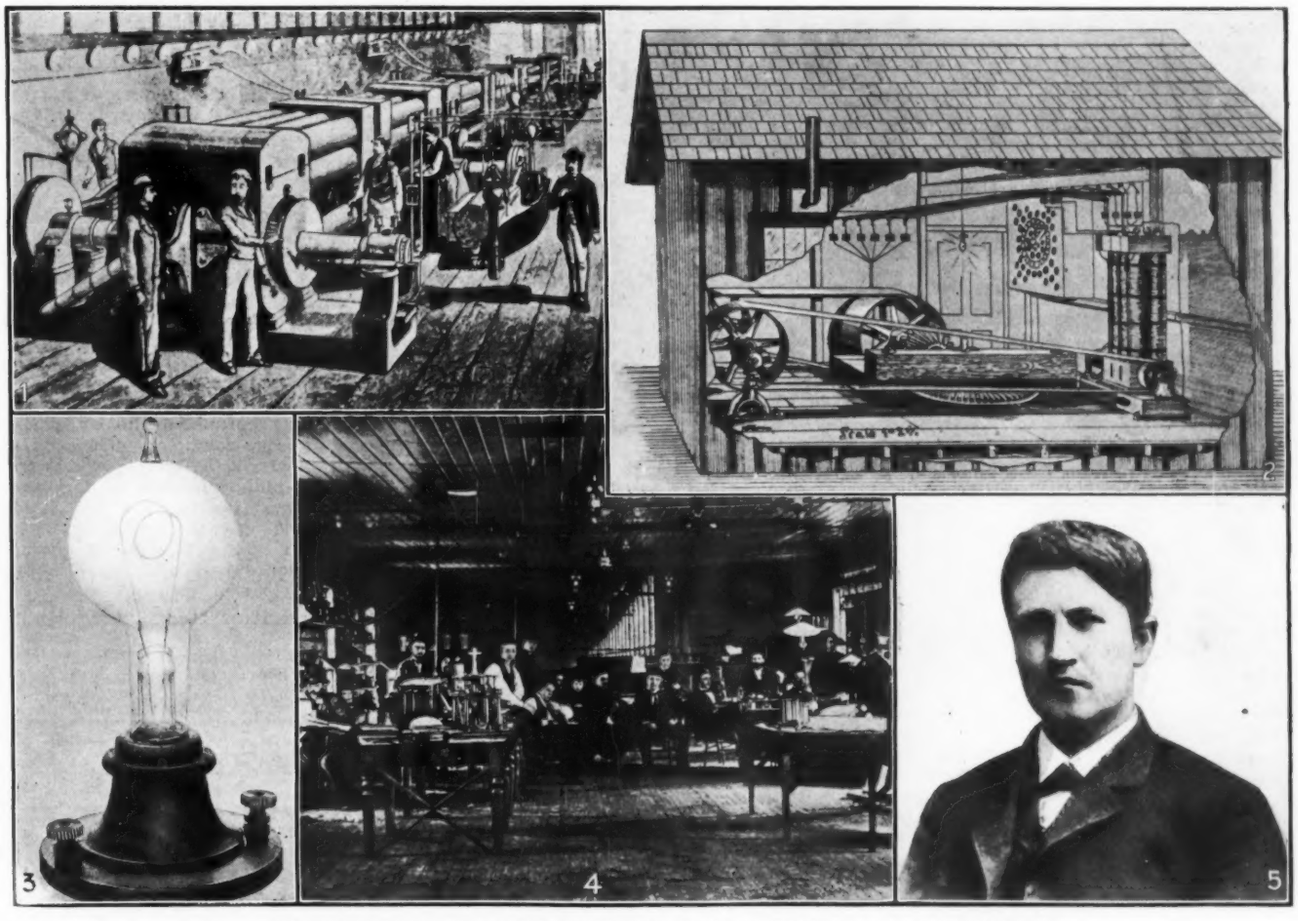
Last year a movement was started among electrical interests to designate Oct. 21 as "Edison Day" in commemoration of the invention of the incandescent electric lamp; this year occurs the 36th anniversary.

Edison practically began his experiments in electric lighting in September, 1878. Just previous to this he had returned from a visit to a Connecticut factory where an electric arc lamp was used. This drew his attention to the subject of lighting by electricity, and he determined to tackle the problem. The task before the young inventor involved, commercially, the production of a pure, steady and reliable light, and producing it so cheaply that it could compete with gas for general illumination. The electrical problems presented constituted: First, a dynamo with a low-resistance armature; secondly, a high-resistance lamp of relatively low candlepower, and thirdly, a distributing system on which the lamps could be connected in multiple instead of in series. All these ideas were revolutionary.

Of the two systems before him, the voltaic arc and the incandescent lamp, Edison chose the latter as the most practical for the subdivision of electric lighting into small units. The discovery of the proper substance and the methods of securing the incandescence proved a problem. The substances that were experimented with included arc-light carbon made into a paste and rolled into threads, cotton thread, vulcanized fiber, jute, palm fiber, grasses, carbonized flax, threads made of lampblack and tar, charcoal, hemp, soft paper, fishline and a number of varieties of woods, lampwick, cork and bamboo fiber. The practical filament was finally found in the fiber growing just under the outside hard surface of a certain variety of bamboo.

Carbonized bamboo was used for about 10 years and was then followed by the squirted filament employing carbonized cellulose, many metalized-carbon filaments, the pressed-tungsten filament, and finally a special form of drawn tungsten wire used in the modern mazda lamp. Working down from a consumption of four or five watts per candlepower in the carbon-filament lamp to the standard of a few years ago of 3.1 watts per candlepower, the madza lamp has brought this down in about five years to 1 watt per candlepower; while in the larger sizes the gas-filled lamps have reached the low figure of nearly one-half watt per candlepower.

Commenting upon his early investigations in the search for a proper filament, Edison says:



PHOTOGRAPHS ILLUSTRATING SOME OF EDISON'S EARLY WORK

Fig. 1—Interior of Pearl Street Station. Fig. 2—First commercial station in the United States, at Appleton, Wis. Fig. 3—First Edison incandescent lamp. Fig. 4—Edison's laboratory at Menlo Park, 1879. Fig. 5—Edison at the time he brought out the incandescent lamp.

Finally, on Oct. 21, 1879, I carbonized a piece of treated cotton sewing thread bent into a loop and sealed it in a glass tube from which the air had been pumped. When the current was turned on the thread glowed for 40 hr. That was really the first incandescent electric lamp. We sat and looked, and the lamp continued to burn, and the longer it burned the more fascinated we were.

A little later several hundred paper-filament lamps were placed on the market. Later, in experimenting with metal filaments it was discovered that they lost weight. This lowered their resistance and was fatal to the lasting qualities. To remedy this a vacuum bulb was adopted.

The next great problem that Edison handled was a system of distribution. Prior to 1880 there was no method known by which a large number of electric lights could be operated practically over large areas. Speaking of this period, Edison has said:

I had the central station in mind all the time, and I wanted to use 110 volts. There is no use asking why, because I do not know, but somehow that figure stuck in my mind, and I had calculated that if we could get the voltage up that high the copper cost would be somewhere within sight.

Commenting further on the first central station, the old Pearl St. station in New York City, he is quoted as saying:

You cannot imagine how hard it was. There was nothing that we could buy nor that anybody could make for us. There were no high-speed engines, and the manufacturers said they were impossible.

Mr. Porter, of the old Porter-Allen Engine Co., built for this station his first high-speed engine, of 150 hp. and 700 r.p.m.

We set the machine up in the old shop, and as we had some idea of what might happen, we tied a chain around the throttle valve and ran it out through a window into the woodshed, where we stood to work it. Every time she turned over she shook the firmament and tried to lift the whole hill with her. Toned to 350 r.p.m., she ran satisfactorily.

Simultaneously, distribution mains were being laid in New York. On the day when the system was tried out, Edison relates that one engine was started and ran satisfactorily with 500 ohms resistance in circuit. Then the other engine was started and the two units thrown in parallel, with the result that one engine would stop and the other would run up to nearly 1,000 r.p.m. Then they would seesaw. Naturally, the governors were blamed and the trouble was finally remedied by connecting all the governors together. At that time there were no switchboard instruments in use, and in the early work it was customary to hang up a nail alongside of the feeder to serve as a petty current ammeter. When the nail came close to the feeder, indicating a heavy load, the rheostat on the machine was adjusted and the voltage on the lamps at the station was kept about right.

The accompanying illustrations pertaining to Edison's early work are presented through the courtesy of the General Electric Co.

Seattle Power Developments

Six power projects, developed to any reasonable capacity that may be desired by the City of Seattle, are now under consideration by J. B. Ross, superintendent of lighting. Included in the number is the Elwah project offered some time ago and now being investigated. The names of the others will not be made public until an investigation has been made, the proponents of each having agreed to take payment in utility bonds drawing 5 per cent. interest, principal and interest payable from the earnings of the lighting plant and the property so purchased.

A. H. Dimock, city engineer, is now making an investigation of the Sauk and Suiattle project, about 30 mi. northeast of Seattle. This development is in the national reserve, and the city has made application to the Government for development rights. It is estimated that the only investment the city would have to make would be for power sites and right-of-way for transmission and pipe lines, not exceeding $25,000.

The plan of calling for bids for sealing the basin back of the Cedar River dam by any means the bidder might see fit to employ will be abandoned, as the courts have decided that the charter requires that plans and specifications be prepared first and bids called for from contractors. As no plan has ever been devised, there is every indication that little or no work will be done on the Cedar River improvement for some time. The city officials are anxious to acquire a power project that will meet Seattle's requirements in order that the operation of an expensive steam plant may be abandoned.

Permits Company to Raise Rates

The New York Public Service Commission, Second district, has permitted the Lockport Light, Heat and Power Co. to increase its rates on its showing that it was not earning a fair return on the capital employed. An agreement was reached between the city and the company's representatives during the hearings that the actual fixed capital of the company employed in the electric business was $467,435.66, not including working capital and certain intangibles that the company claimed should be charged against a reproduction cost. These sums amounted to another $170,000, but the commission pointed out that it was not necessary to go into this contested field, as even on the valuation of $467,435.66 the shareholders could get but little over 2 per cent. on their investment. A schedule has been worked out which will enable the company to earn an increased revenue of $41,667 per annum if it is able to retain all its present customers. The new schedule is as follows:

Residence Lighting—Net consumer charge: 75c. per month per meter. Net energy charge: 5c. per kw.-hr. for first 35 kw.-hr. per mo., 2c. per kw.-hr. for all excess. Discount: Gross bills to be rendered with 10c. added to net consumer charge and discounted to net rate if paid within 10 days.

Commercial Lighting—Net rate: 10c. per kw.-hr. for first 60 hr. use per month of demand; 5c. per kw.-hr. for next 60 hr. use per month of demand; 2c. per kw.-hr. for all excess; minimum charge: $1 per month per meter. Demand to be considered as 90 per cent. of total installed capacity. No installation to be considered as less than 1 kw. Gross bills to be rendered with 1c. per kw.-hr. added to net rate for first 60 hr. use per month of demand, and discounted to net rate if paid within 10 days.

Commercial Power—Net rate: 7c. per kw.-hr. for first 40 hr. use per month of demand; 4c. per kw.-hr. for next 40 hr. use per month of demand; 1c. per kw.-hr. for all excess. Minimum charge: $1 per hp. per month for first horsepower installed, 75c. per month per hp. in addition. Demand will be considered as 75 per cent. of installed capacity if in one motor and 65 per cent. if in more than one motor. No installation to be considered as less than 1 kw. Gross bill to be rendered with 1c. per kw.-hr. added to net rate for first 40 hr. use per month of demand and discounted to net rate if paid within 10 days.

Wholesale Light and Power—Net demand charge: $2.50 per month per kilowatt for first 5 kw. of maximum demand; $1.25 per month per kilowatt for each additional kilowatt of maximum demand. Net energy charge: 1c. per kw.-hr. Gross bill to be rendered with 25c. per kw. added to net demand charge and discounted to net rate if paid within 10 days.

Recent Court Decisions

Digested by A. L. H. STREET

Dam as a Nuisance—The fact that the statutes of a state authorize power companies to condemn land and water rights for the purpose of constructing and maintaining dams to supply power for public use does not exonerate such companies from liability to persons who suffer damage from maintenance of the dams in such manner as to constitute a nuisance in creating unhealthful conditions; acquisition of right to flow property does not carry with it right to injure the health of persons living near the dam. (Georgia Supreme Court, Nolen vs. Central Georgia Power Co., 85 "Southeastern Reporter," 945.)

Accident to Employee Off Duty—Applying the general rule of law that an employer is not liable for injury to any employee arising outside the scope of his employment, the Supreme Court of Missouri has decided that a grain-elevator company is not liable for the death of one of its employees, although it may have negligently permitted the equipment to become and remain in a dangerous condition. The man in question was employed in a newly installed electric-power plant, and was killed while at the plant one Sunday afternoon, off duty and on a personal pleasure visit to show two of his friends the motor and how it was operated. The particular negligence relied on by decedent's widow in her suit against the employer was failure to properly insulate the wires above disconnecting switches and to inclose or properly guard the copper blades of the switches. As an independent ground for denying plaintiff's right to recover, the court held that the evidence was insufficient to show that the accident resulted from the negligence charged. (Biddlecom vs. Nelson Grain Co., 178 "Southwestern Reporter," 750.)

OBITUARY

GEORGE W. STIVERS

Chief Engineer George Washington Stivers, U. S. N., retired, died at his home in Brooklyn, Oct. 3. He was born in 1836, and entered the navy as third assistant engineer in 1861. He served on the steam sloop "Oneida" and the steamer "Union" in the Civil War, and later was on the "Franklin," "Dictator," "Pabos," "Intrepid," "Pensacola," "Essex" and "Baltimore." He became chief engineer in 1885 and was retired for age in 1898. During his active service he had been at sea for 15 years and had shore duty 18 years.

NEW PUBLICATIONS

COMBUSTION AND SMOKELESS FURNACES—By Jos. W. Hays. Second edition, revised. Published by G. L. Simmonds & Co., 230 La Salle St., Chicago. Cloth; 6x9 in.; 116 pages. Price, $2.

The book begins with explanations of some theories of heat and of the physics of heat as applied to combustion. The

application of it to boiler furnaces is taken up in Chapter II, and among other tables is one showing the percentages of fuel loss for various percentages of CO_2 in the flue gases. From here on the author treats of the smoke evil as influenced by different kinds of stokers and furnaces. One would like to find in a book of this kind more about results with specific makes and kinds of furnaces—arches, stokers, etc.—although in some particulars, the steam jet for example, the author is quite complete in his treatment. He concludes that for the purpose of obtaining smokeless combustion the steam jet is not worth the price.

DYNAMOMETERS—By F. J. Jervis-Smith. Edited and amplified by C. V. Boys. Published by D. Van Nostrand Co., New York. Cloth, 5½x8½ in.; 267 pages; 119 illustrations. Price, $3.50.

The leading criticism of this work is that it has the defect of disconnectedness, besides being burdened with more or less irrelevant matter. But some excuse for the arrangement of the work may be found in the fact that the book was edited from manuscript which was not finished during the life of the author.

Chapter I discusses the importance of dynamometric tests, describes the early work done by Smeaton and Hirn, and gives some dissertations on Watt's determination of the horsepower unit, Farey's slide-rule and the conditions under which work is best performed by men. Chapter II briefly sets forth the laws of friction and cites the results of some experiments. Chapter III describes planimeters and integrators and their applications to power-measuring devices. Chapter IV takes up friction and absorption brakes of the types of Prony and Alden, showing various constructions and means for automatic adjustment. Chapter V deals with water brakes, giving a detailed description of the Froude turbine dynamometer, but besides briefly mentioning the Brotherhood brake, this chapter contains little else on this important type of dynamometer. The title of Chapter VI, "Air Brakes," is misleading to American engineers, who are accustomed to associate the term with car equipment. With us the material would be better known under the title "fan brakes." Chapters VII and VIII are respectively devoted to short descriptions of magnetic brake dynamometers and end-thrust brakes. Chapter IX is largely a discussion of the work that men are capable of doing, contains some historical matter, and alludes to experiments on the resistance of liquids. Chapter X gives good descriptions of about twenty-five forms of transmission dynamometers, embracing forms best known to British and Continental engineers. It is rather notable that the list embraces brief descriptions of but two American forms—those of Rudduck and Neer—both, many years ago, superseded in this country by numerous other types of which the author makes no mention. Chapters XI and XII give good descriptions of the principles and some types of torsion dynamometers. It is to be regretted that the author had not shown details of more dynamometers of this type, as they have grown into importance since the introduction of steam turbines and other high-speed motors. Chapter XIII sets forth the principles of cradle dynamometers and describes some types. Chapter XIV treats of dynamometer tests on high-speed internal-combustion engines and also gives a detailed description of the Wimperis Accelerometer. Chapters XV and XVI give short discussions of ship-model and aëronautic dynamometers.

The descriptions are generally good, and it may be said of the book that it presents at least a valuable collection of information on dynamometers, although mainly confined to those best known among English engineers.

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Serious Corrosion of Condenser Tubes at the power station of the Sydney tramways has been completely checked, says Mr. Bates, an Australian engineer, by painting the whole of the interior of the cast-iron waterboxes with an anticorrosive paint. The same remedy was adopted with equally good results at the power station of the Adelaide tramways, where similar trouble had been experienced. In the 15 months during which the system has been in use the number of tubes removed from two older condensers has not exceeded three per month, while formerly it was not uncommon to lose 150 tubes from one condenser in a single week. A great variety of conflicting experience is on record on this subject, and of course it is quite possible that there are peculiar local conditions that make a remedy effective in one place and useless in others. Mr. Bates also states that the electrolytic method "failed after a time," which is taken to mean that it succeeded for a time and then failed. A careful examination is necessary in such a case to find whether the change was due to some defect in, or some accident to, the materials or appliances. Many things fail because they are not properly applied, and this would hold good with anticorrosive paint.—"Practical Engineer," London.

BOOKS RECEIVED

PRINCIPLES OF DIRECT-CURRENT MACHINES. By Alexander S. Langsdorf. McGraw-Hill Book Co., Inc., New York. Cloth; 404 pp., 5½x8¼ in.; 313 illustrations. Price, $3.

EXAMPLES IN ALTERNATING CURRENTS. Vol. 1. By F. E. Austin. Published by the author at Hanover, N. H. Flexible leather; 223 pp., 4¾x7½ in.; 70 illustrations.

HANDBOOK OF MATHEMATICS FOR ENGINEERS. By L. A. Waterbury. John Wiley & Sons, Inc., New York. Leather; 213 pp., 3x5½ in.; 80 illustrations; 110 pages of tables. Price, $1.50.

MODERN BOILER-ROOM PRACTICE AND SMOKE ABATEMENT. By James T. Hodgson. The Railway Engineer, London, Eng. Cloth; 321 pp., 5½x8½ in.; 209 illustrations. Price, 3/6.

THE SLIDE RULE. By C. N. Pickworth. Thirteenth edition. Published by D. Van Nostrand Co., 25 Park Place, New York. Cloth; 122 pp., 7x5 in. Price, $1.

This little book, so extensively known, has been revised and the contents further extended to include descriptions of various new slide rules and calculators. Besides these additions there is a note on the extraction of the fifth root. The book embraces everything in slide-rule practice from multiplication on up through proportion, squares, cubes and roots, gage points, to trigonometrical applications and special calculations.

TRADE CATALOGS

Pennsylvania Boiler Works, Erie, Penn. Catalog R. Tubular boilers. Illustrated, 38 pp., 6½9 in.

B. F. Sturtevant Co., Hyde Park, Mass. Bulletin No. 219. Electric air heater and blower. Illustrated, 6½x9 in.

Scranton Pump Co., Scranton, Penn. Bulletin No. 103. Jet condensers and vacuum pumps. Illustrated, 12 pp., 6x9 in.

Yawman & Erbe Mfg. Co., Rochester, N. Y. Pamphlet. Vertical file for blue prints. Illustrated, 16 pp., 5x7½ in.

A. S. Cameron Steam Pump Works, 11 Broadway, New York. Bulletin No. 154. Centrifugal pumps. Illustrated, 16 pp., 6x9 in.

Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y. Bulletin No. 60. Hauck oil burners and torches in different shops. Illustrated, 16 pp., 6x9 in.

The Armstrong Mfg. Co., Bridgeport, Conn. Catalog No. 14. Stocks and dies, pipe-threading machines, water, gas and steam fitters' tools. Illustrated, 56 pp., 6x9 in.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Booklet No. 213. Simplate flat disc valves. Illustrated, 10 pp., 3½x6 in. Bulletin No. 216. "Hummer" self-rotating hammer drills. Illustrated, 28 pp., 6x9 in.

Morse Chain Co., Ithaca, N. Y. "Chain of Evidence." Publication No. 14. Morse silent chain in textile mills. Illustrated, 12 pp., 6x9 in. "Chain of Evidence." Publication No. 14. Large power drives. Illustrated, 20 pp., 6x9 in.

Bolinders Co., 30 Church St., New York. Catalog No. 1700. Crude-oil engines for auxiliary trading vessels. Illustrated, 16 pp., 9x12 in. Catalog in Swedish, English, German, French, Russian. Boilers, steam engines, steam turbines, oil engines, sawmill machinery, etc. Illustrated, 9x12 in.

BUSINESS ITEMS

The Lunkenheimer Co., Cincinnati, Ohio, has been awarded the Medal of Honor at the Panama-Pacific International Exposition, and the Grand Prize at the Panama-California Exposition.

Thomas R. Tarn, of Division Engineer Department of Public Works, Pittsburgh, Penn., has won the prize which the Homestead Valve Manufacturing Co., Homestead, Penn., offered for the best trade name suggested by readers of this paper for the new gate valve. Three to four hundred names were suggested. The name which won the prize is "Neway" although the company has changed the spelling to "Nuway" so that the name can be more easily pronounced and recognized.

The Goulds Manufacturing Co., of Seneca Falls, N. Y., has opened a Philadelphia office at 111 N. Third St. It has purchased the business of H. E. Trotman, who had been distributor for Goulds pumps in this territory and has leased from him the store room and warehouse at the above address. E. S. Jenison, formerly with the Canadian Fairbanks Co., Ltd., Montreal, has been appointed manager; F. G. Kramer, assistant manager. Mr. J. B. Trotman will continue with the Goulds Manufacturing Co.

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National Exhibitors' Association—In the report of the N. A. S. E. convention, Sept. 28 issue, the name of Paul T. Payne should appear as treasurer instead of that of Harry Pastre.

New Equipment

Mass., Boston—Plans are being prepared for an automatic pumping station for South End. Estimated cost, $400,000.

Conn.—South Norwalk—The Municipal Electric Light Plant contemplates improvements.

N. Y., Buffalo—Plans being considered by Buffalo Cold Storage Co., for power house. Estimated cost, $45,000.

N. Y., Corning—A company is being organized to construct a reservoir to utilize the waters of Lake Wayne and Lamoka, also to construct a hydro-electric plant on the shores of Lake Keuka to develop 150,000-hp. and to transmit electricity to Corning and Hammondsport. A dam will be built on the David Smith farm and electricity will be transmitted to Savona, Campbell, Bath and other places. Robert O. Hayt, Corning, Engr.-in-Charge.

N. Y., New York—(Borough of Brooklyn)—Bids will be received by Samuel McGowan, Paymaster Gen., Navy Dept., Washington, D. C., until Oct. 26, for 25 ¼-hp. portable ventilating sets.

N. Y., Syracuse—Construction of a substation on West Fayette St. to distribute Niagara and Salmon River power in Syracuse contemplated by Syracuse Light Co. The proposed station will be equipped with three motor generator sets with an approximate output of 12,000-hp. The station will include apparatus to supply electricity for about 700 street lamps. Plans are also being considered for an addition to Solvay substation to include building equipped with 20,000-hp. transforming apparatus. Estimated cost, $500,000. J. C. De Long, Pres.

N. Y., New York—(Borough of Richmond)—Richmond Light & R.R. Co. plans to make improvements to its plant at New Brighton. Among the equipment required are 7,500-kw. turbines, 1,200-hp. boilers, 300-hp. motors and condensers. W. H. Rudisill is Engr. of the station.

Penn., Bally—Citizens voted $6,000 bonds for municipal electric-light plant.

Penn., Philadelphia—A permit has been granted to the Roydhouse-Arey Co., Fidelity Bldg., Philadelphia, for a power house at the Children's Hospital. Estimated cost, $2,200.

D. C.—Washington—Bids will be received by James A. Wetmore, Acting Supervising Arch., Treasury Dept., Washington, D. C., until Nov. 17, for the construction of a central heating, lighting, and power plant at Washington.

D. C., Washington—Bids will be received by Samuel McGowan, Paymaster Gen., Navy Dept., Washington, until Oct. 26, for furnishing gate valves, pressure reducing valves and rough brass valves at Boston, Mass., and Philadelphia, Penn., under Schedule 8870.

D. C., Washington—Bids will be received by Samuel McGowan, Paymaster Gen., Navy Dept., Washington, until Oct. 26, for three 125-hp. induction motors under Schedule 8859.

D. C., Washington—Bids will be received by Samuel McGowan, Paymaster Gen., Navy Dept., Washington, until Nov. 2, for three 75-kw. transformers under Schedule 8877.

Va., Mineral—The city plans to establish an electric light plant and water system.

W. Va., Hinton—Reports state that the Virginia Western Power Co. contemplates the erection of an electric plant near Hinton for the purpose of furnishing nearby towns with electricity. Wm. E. Mathews is Pres.

W. Va., Madison—The Royal Block Coal Co. is in the market for electric-power equipment for operating cutting and hauling machinery.

W. Va., Mineral—City Council plans to install electric-light plant and water system.

N. C., Lenoir—Construction of hydro-electric plant at Poovey Shoals contemplated by Citizens Light & Power Co.

S. C., Orangeburg—City plans to improve and enlarge the electric-light plant. Estimated cost, $50,000. Edward Hawes, Jr., City Engr.

S. C., Walhalla—The Commissioners of Public Works will build an electric light plant and plan to install two 25-hp. Diesel engines; also extra equipment.

Ga., Atworth—The city will construct an electric light plant and water works.

Ga., Cumberland Springs—(Tullahoma post office)—Plans being considered by Cumberland Springs Co. for electric-light plant.

Ga., Nicholls—The Public Utility Co., Waycross, will install an electric light plant and water works. In the specifications are included the following: 50-hp. crude, gas or kerosene engines, to be used in connection with a 35-k.v.a. 3-phase 60-cycle 2,300-volt generator (belted); also deepwell pump with a capacity of 30 gal. per min., connected by belt to the above engine; and a water tank of 18,000- to 25,000-gal. capacity. Estimates are now being received for this work.

Ala., Birmingham—Bids are being received by Julian Kendrixk, City Engr., for engine and generator for North Birmingham municipal electric-light plant. Estimated cost, $11,000.

Tenn., Chattanooga—The Hill Ice Cream Co. has increased its capital stock from $10,000 to $40,000. The company plans to build a manufacturing building and will install power equipment.

Ohio, Cleveland—Construction of a power plant at East 55th St. and New York Central R.R. contemplated by Cyclone Woven Wire Fence Co. Estimated cost, $150,000.

Ohio, Elyria—Lorain County Engineering Co. has submitted plan to City Council estimating cost of municipal electric-light plant at about $200,000.

Mich., Battle Creek—Citizens Electric Co., is building a 40x60-ft. generator room and a 42x60-ft. addition to the boiler room. Estimated cost, $30,000.

Wis., Hayward—City Council plans to improve water system and to install steam, oil or electrically driven pumps, steel tower and tank. Estimated cost, $10,000.

Iowa, Marathon—Citizens voted $12,000 bonds for electric-light plant.

Minn., Bertha—A franchise has been granted to the Bottenmiller Co. to install and operate electric-light plant.

Minn., Hibbing—Bids will soon be called for the construction of a transmission line sub-station on high tension line to the new water system.

Kan., South Haven—Bids will soon be received by J. R. Britton, Engr., South Haven, Kan., for furnishing one 30-kw. power unit, estimated to cost $2,000.

Neb., Magnet—P. J. Sandberg will soon be in the market for equipment for an electric-light and water plant.

N. D.—Hunter—The Hunter Light & Power Co. plans to purchase the following: Engine-driven generating unit, pumping equipment, switchboard, meters, and various equipment for the street lighting system. R. D. Hockridge is Secy. and Gen. Mgr.

Mont., Perry—Franchise has been granted to L. H. Gaffney by the town council to install and operate electric lighting plant.

Mo., Columbia—The city will increase the capacity of its electric-light plant.

Mo., Lees Summit—Henrici, Kent & Lowry, Consult. Engr., Reserve Bank Bldg., Kansas City, prepared plans for water system with electrically driven pumps. Estimated csot, $45,000.

Ark., Gravette—The City Council plans to install engines in the electric light plant, also in the water works.

Ark., Gurdon—It is reported that F. E. Wright will install a power plant at his theater.

Ark., Morrilton—The Arkansas Light & Power Co., Arkadelphia, has acquired the electric light, also the water plant at Morrilton, and will install new equipment. Reports state that inquiries are now being made for a 500- and 350-kw. horizontal turbine generator.

Ark., Tuckerman—A company is being organized to install electric-light plant in Tuckerman.

Tex., Atlanta—The Atlanta Electric & Ice Co. contemplates the installation of equipment in its electric-light plant.

Tex., Wharton—The plant of the Wharton Ice & Power Co. has been purchased by the Texas Southern Electric Co. of Victoria, who will improve same.

Okla., Goltry—Election will soon be held to vote $10,000 bonds for municipal electric-light plant.

Okla., Lahoma—Plans being considered for municipal electric-light plant.

Okla., Langston—Press reports state that the Meadwell Agricultural and Mechanical College will rebuild its light and heating plant recently destroyed by fire. J. G. Ralls is Chn. of the Board.

Idaho, Kendrick—A. V. Dunkler has applied to Public Utilities Commission, Boise, for permit to install electric power plant. Estimated cost, $8,000.

Idaho, Lewiston—The Deer Creek Milling & Mining Co. plans to construct a steam plant which will require boilers and engines.

Wash., Prescott—Overlook Mining Co. contemplates the construction of a hydro-electric plant.

Wash., Wenatchee—Fire, Sept. 24, damaged the Driden Station of the Wenatchee Valley Gas & Electric Co. Loss between $5,000 and $6,000.

Calif., Fall River Mills—California Power & Mfg. Co., San Francisco, is building a power plant in Fall River Mills to supply electricity for irrigation purposes and lamps and motors. M. P. Holmes, San Francisco, Engr.-in-Charge.

Calif., Orange—City plans to install municipal electric-light plant.

Ont., Granton—Town Council considering installation of hydro-electric system. Estimated cost, $5,000.

Ont., Ridgetown—Construction of hydro-electric power station contemplated. Estimated cost, $10,000.

Ont., Toronto—Northern Ontario Power Co. will increase the capacity of its power plant at Porcupine. Estimated cost, $500,000.

B. C., Vancouver—Press reports state that R. D. Winch & Co., Ltd., Winch Bldg., Vancouver, is in the market for one steam driven air compressor of from 325 to 400 cu.ft. air per min., with receiver, etc.